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(54) **ROLLER GRILL**

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claimer.

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See application file for complete search history.

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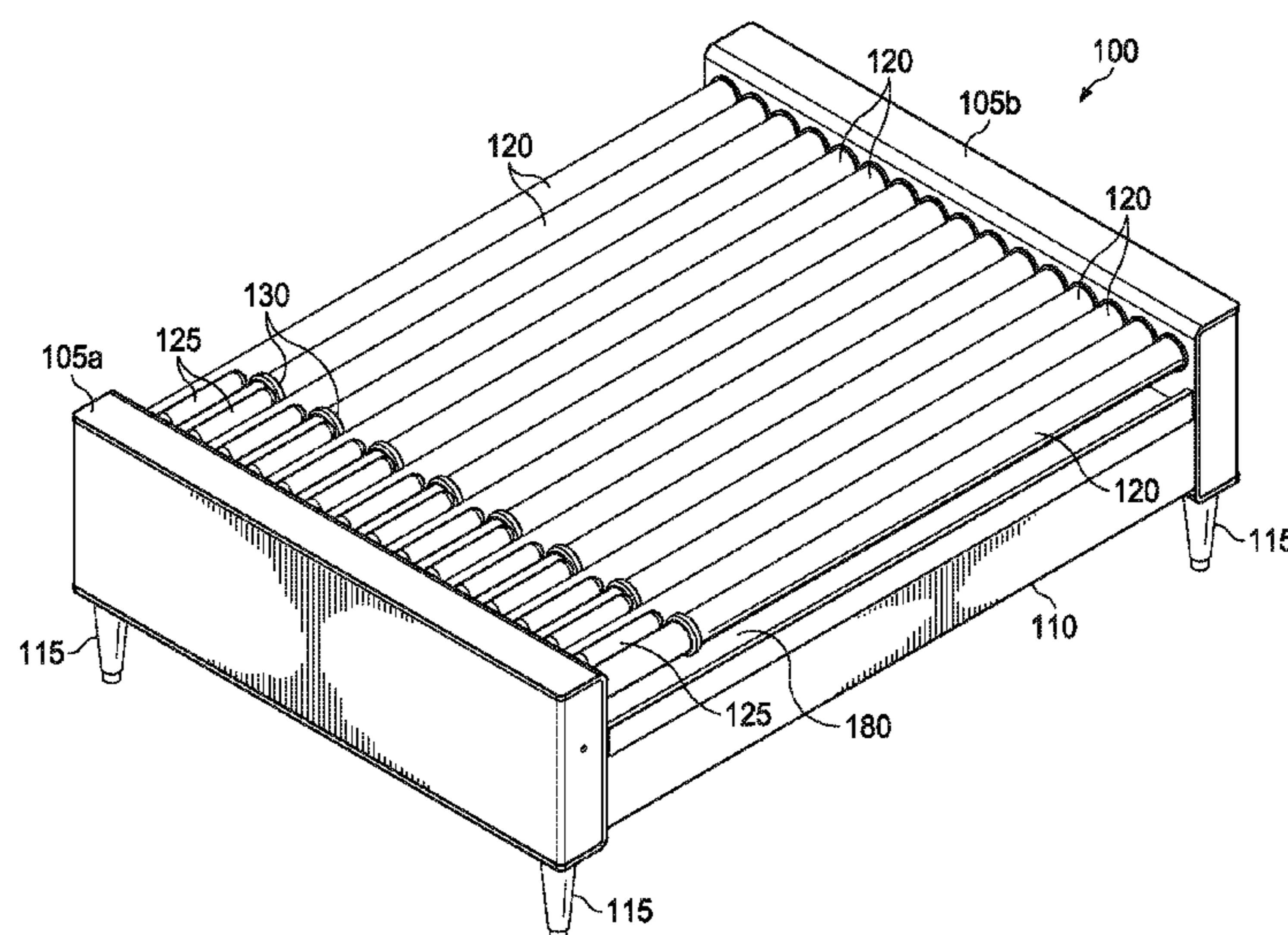
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(57) **ABSTRACT**

A roller grill includes a housing structure adapted to support
the roller grill; a plurality of tubes having outer surfaces
adapted to transfer heat to a pre-cooked food product; a plu-
rality of rollers mounted in a row, each roller mounted on an
end of a corresponding tube and including a plurality of
detented projections extending from a circumferential sur-
face of the roller; and a drive assembly. The drive assembly
includes a continuous looped surface coupled to a motor shaft
and contactingly engaged with the detented projections of the
plurality of rollers. The roller grill further includes a protru-
sion mounted to the housing structure and in contacting
engagement with the continuous looped surface, such that the
continuous looped surface is contactingly engaged with at
least two detented projections of each roller of the plurality of
rollers mounted in the row.

12 Claims, 21 Drawing Sheets



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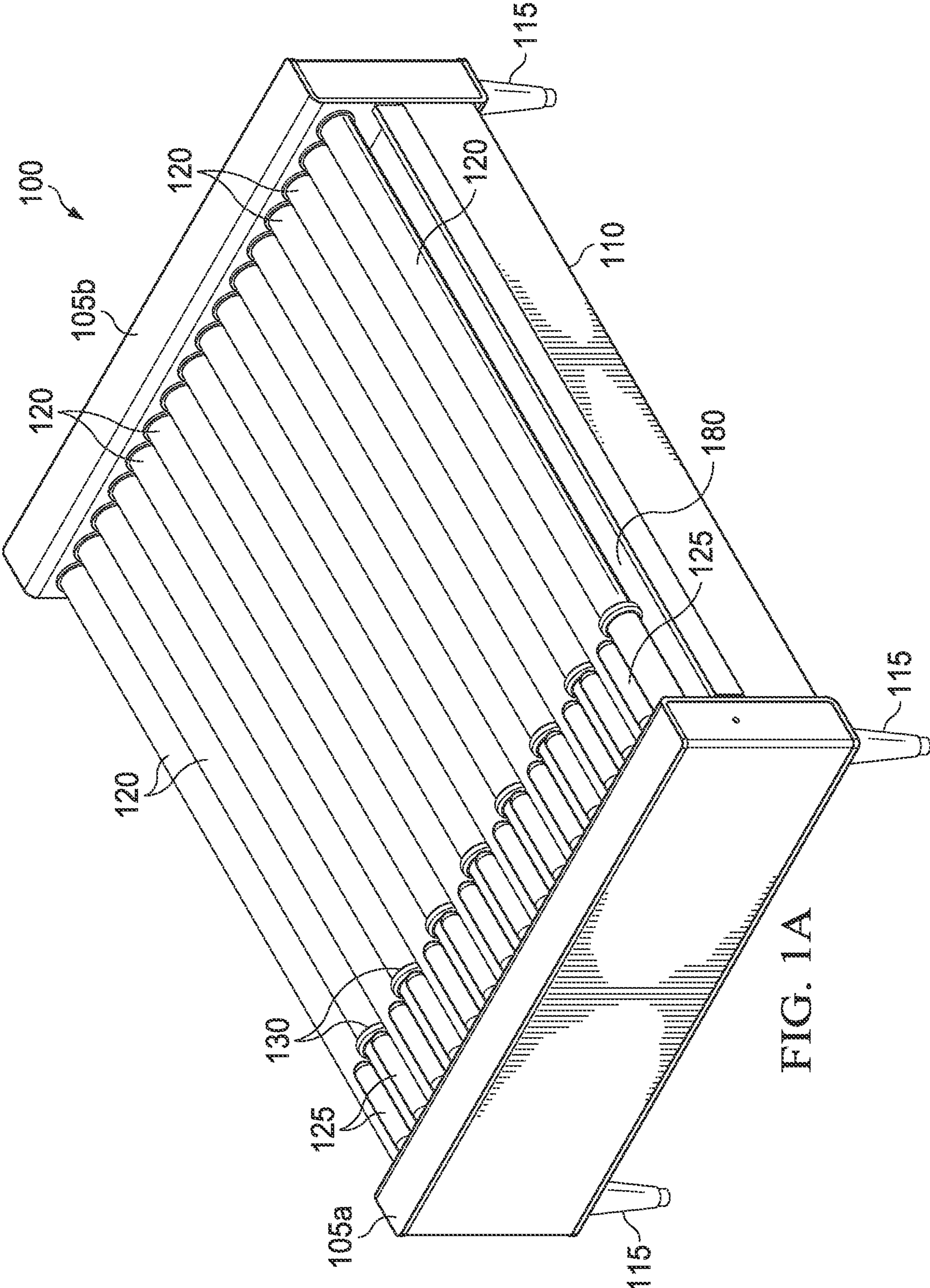
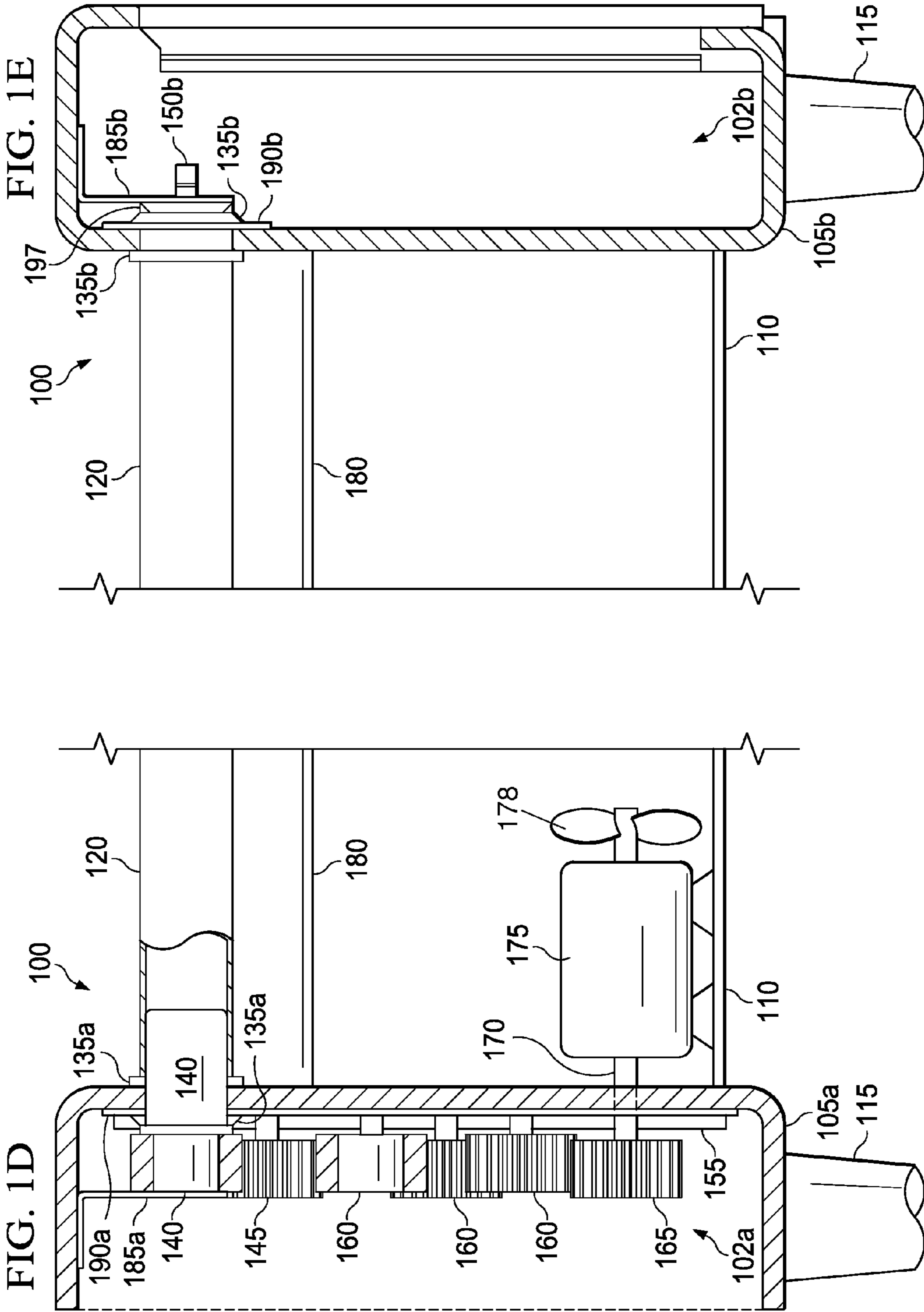
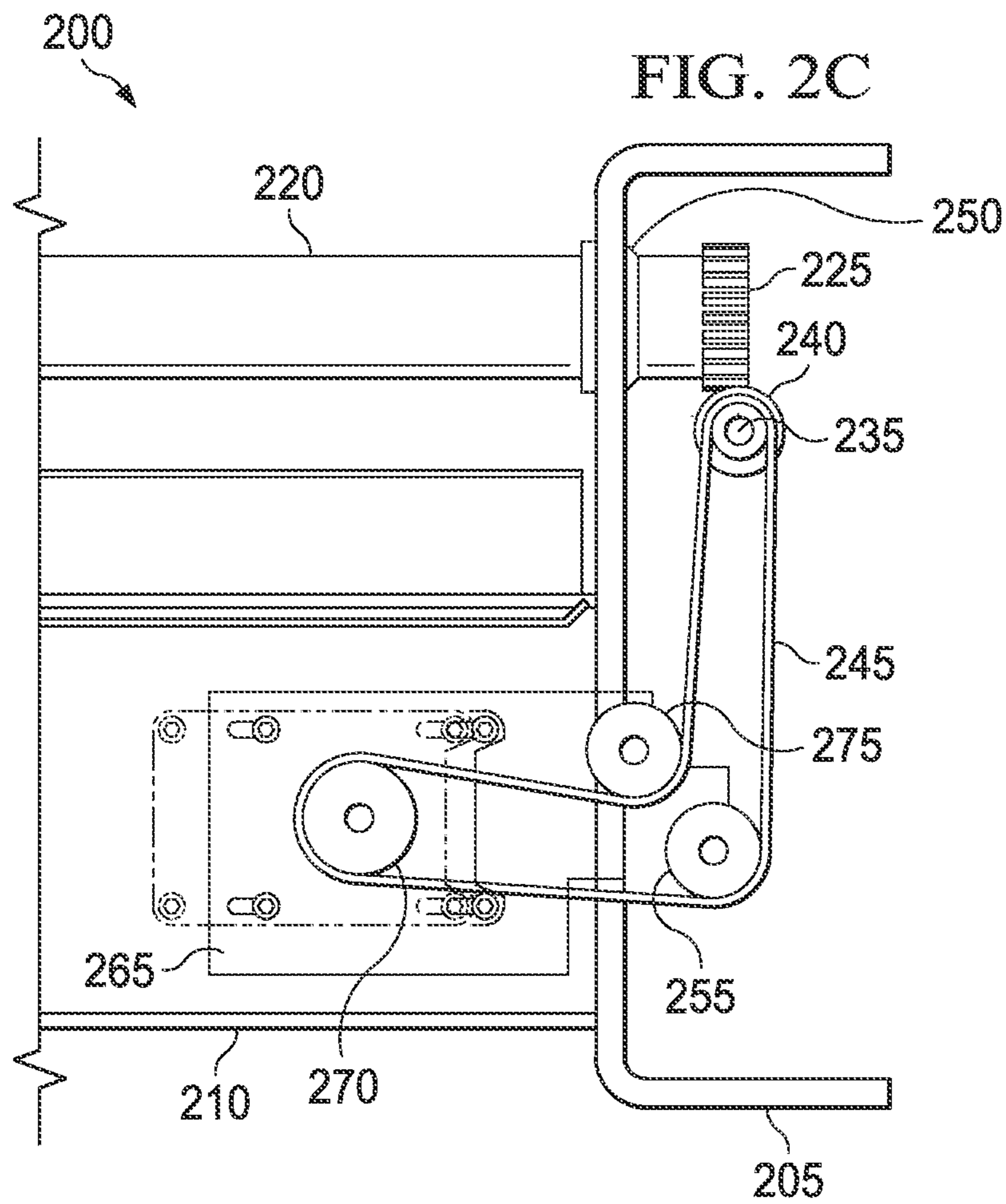
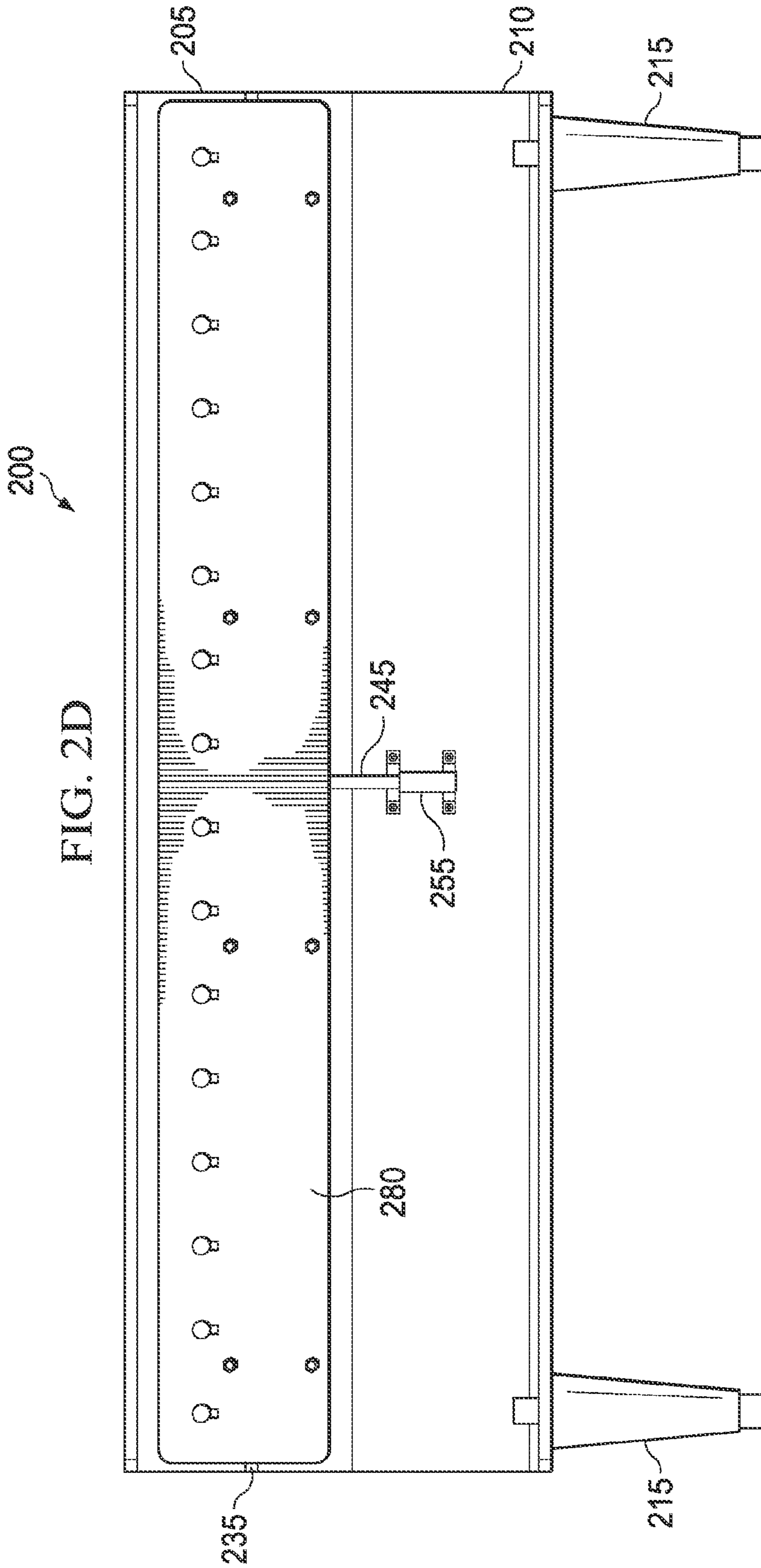


FIG. 1A







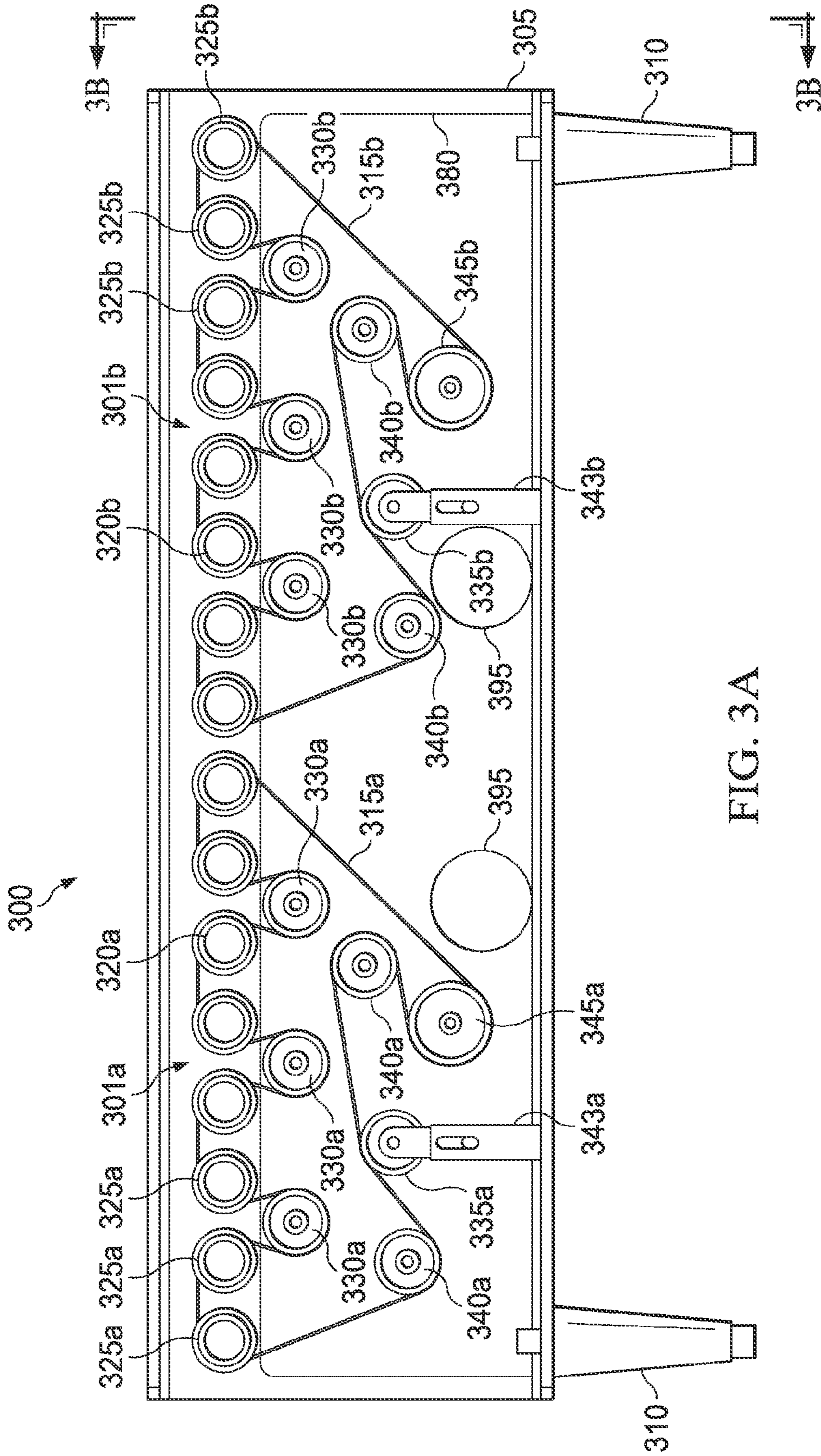


FIG. 3A

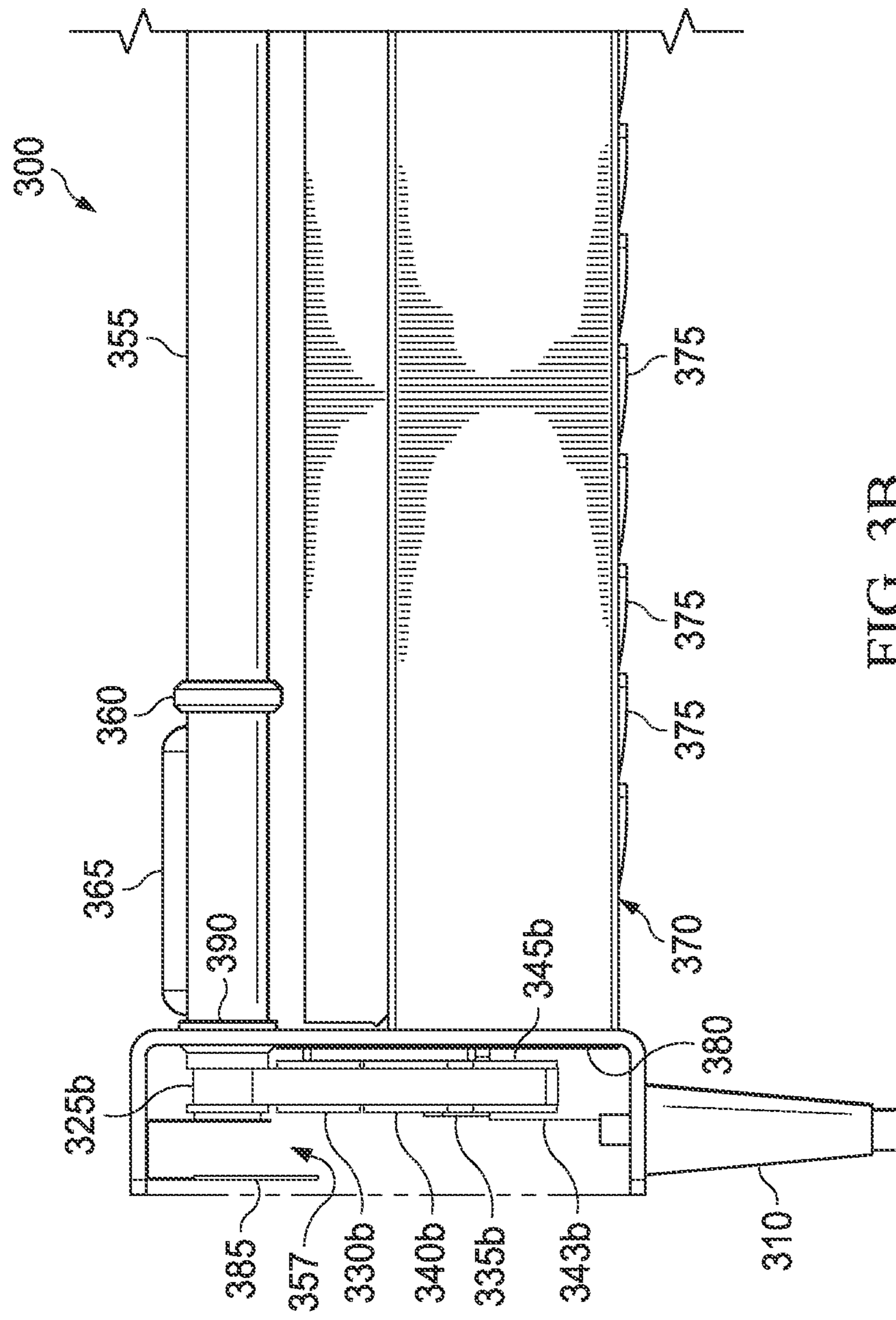


FIG. 3B

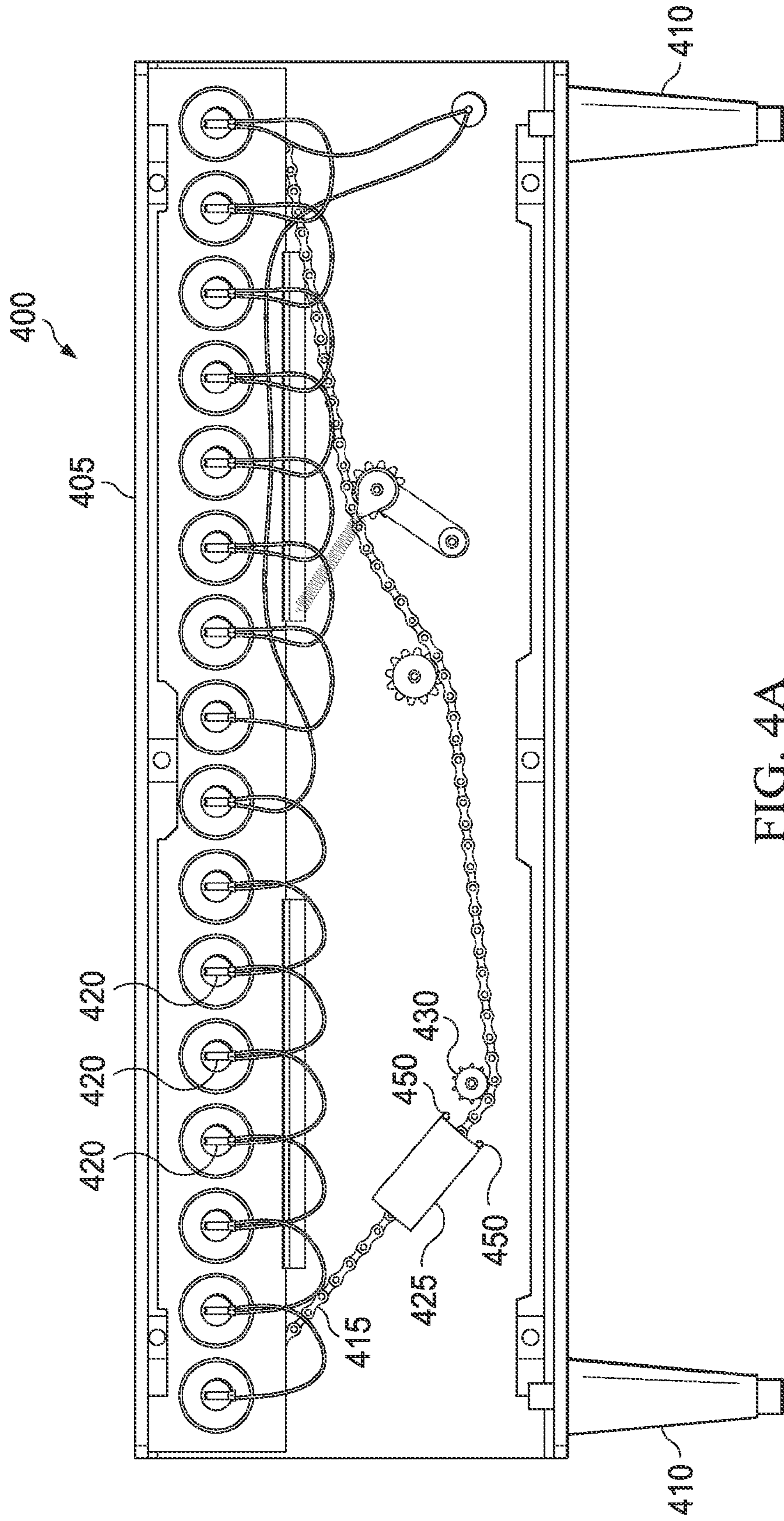


FIG. 4A

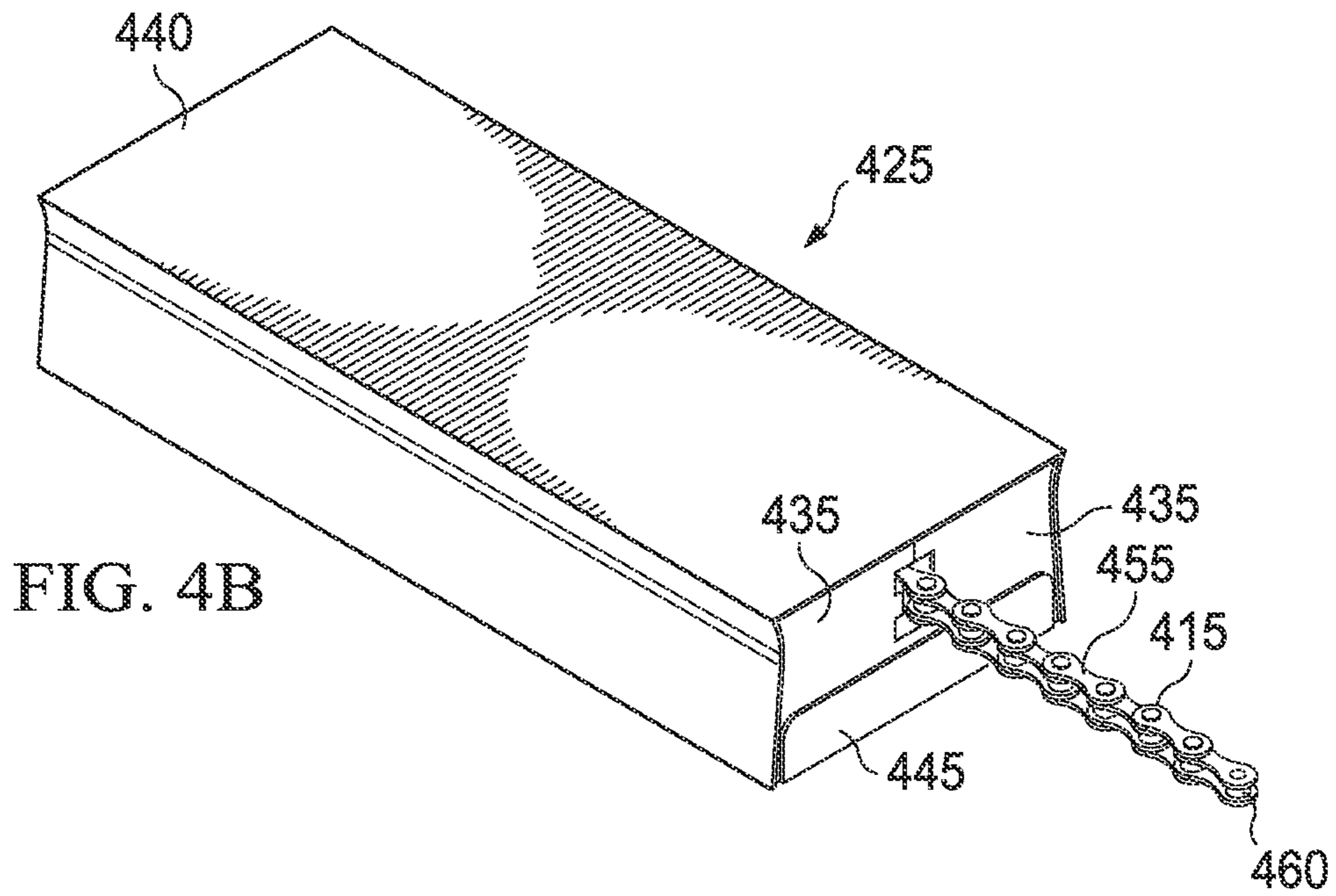


FIG. 4B

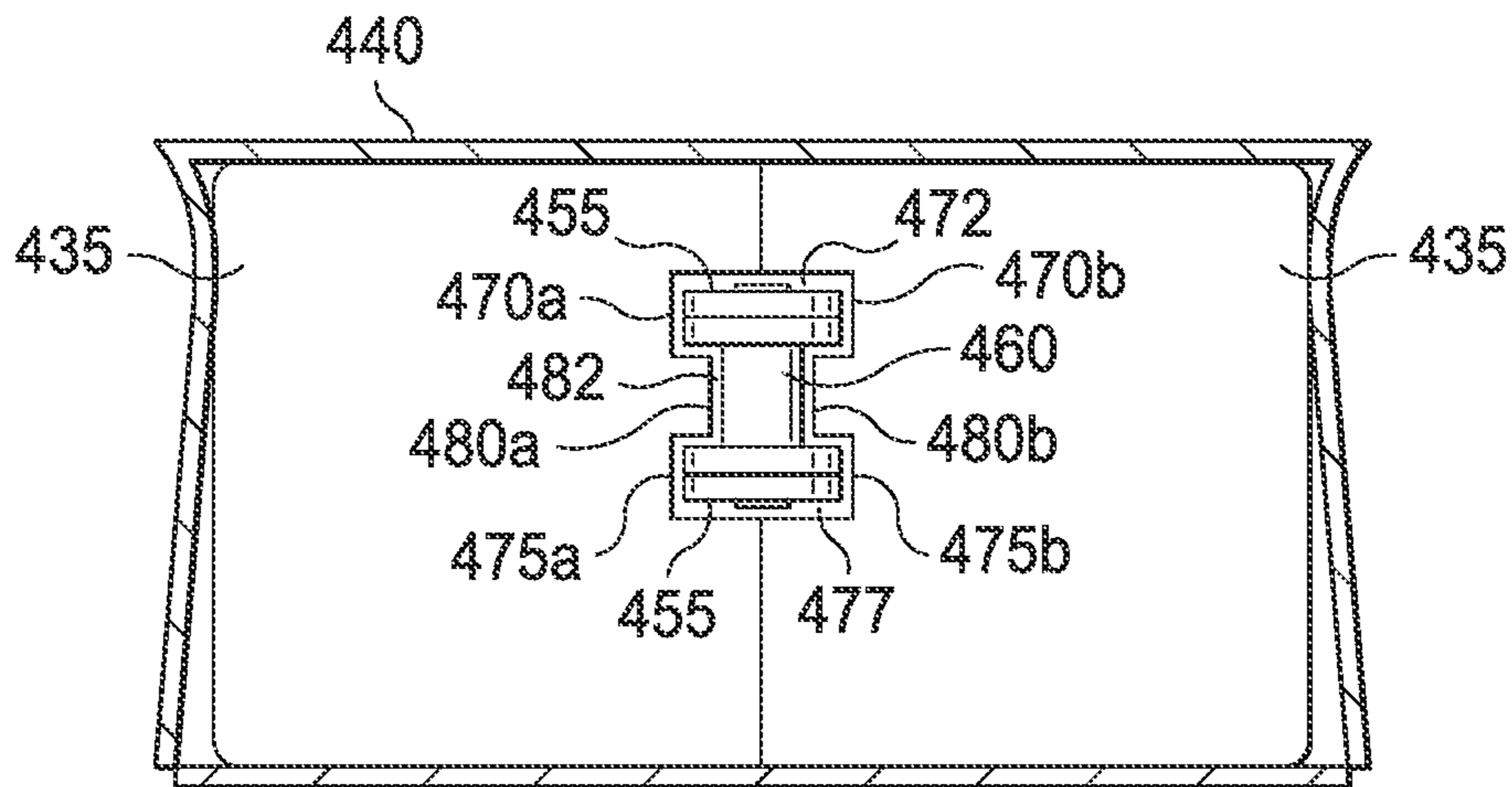
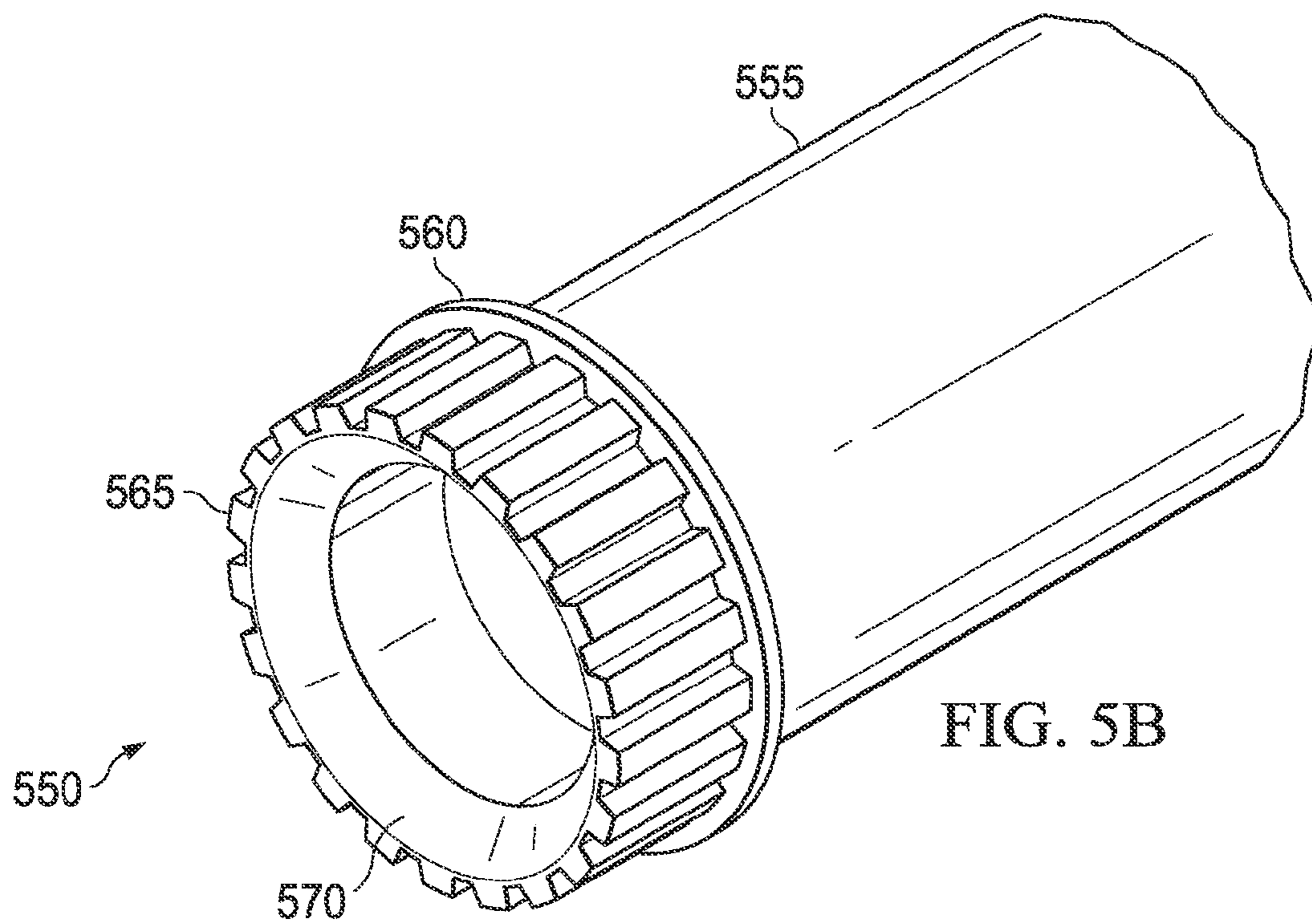
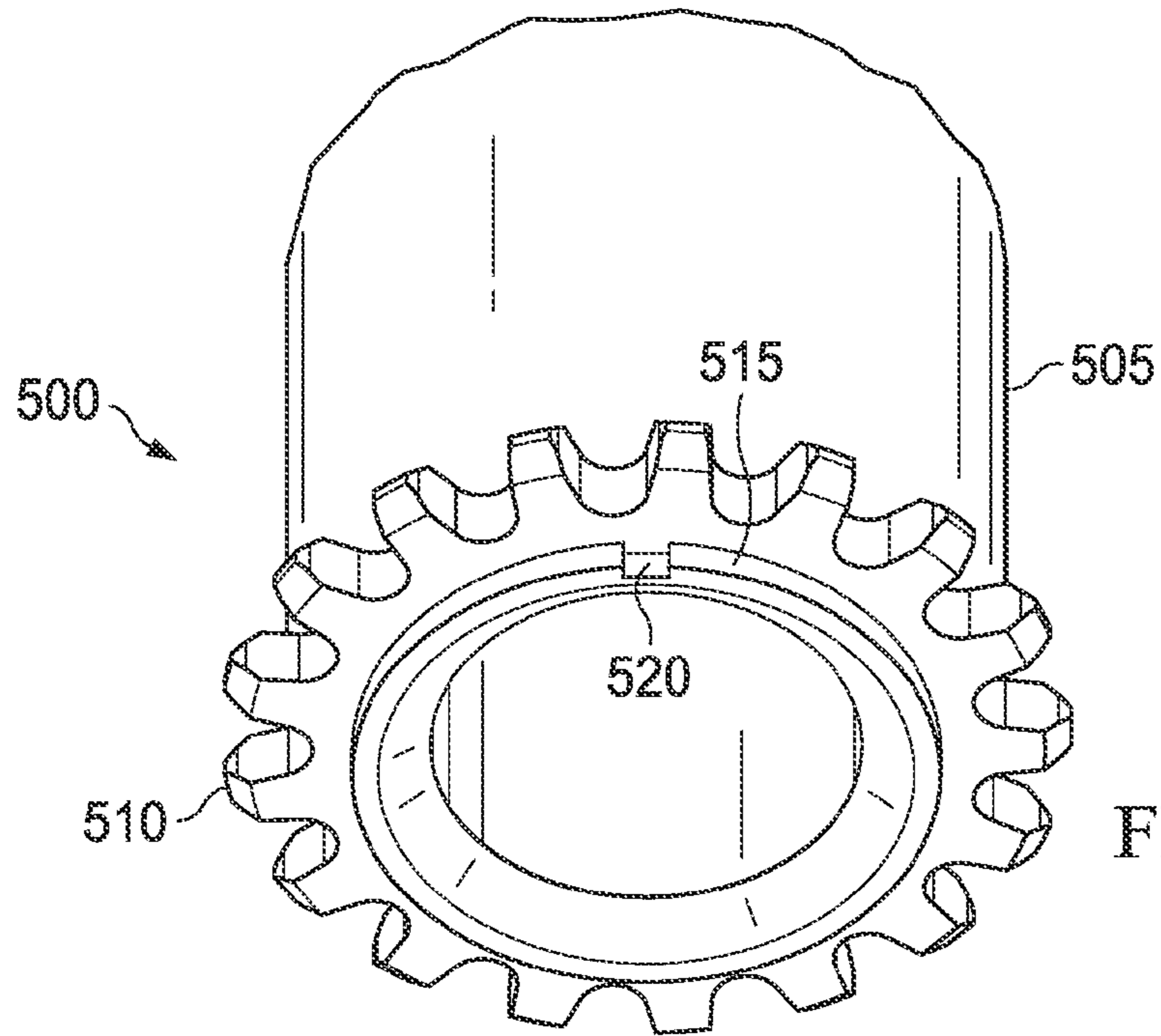


FIG. 4C



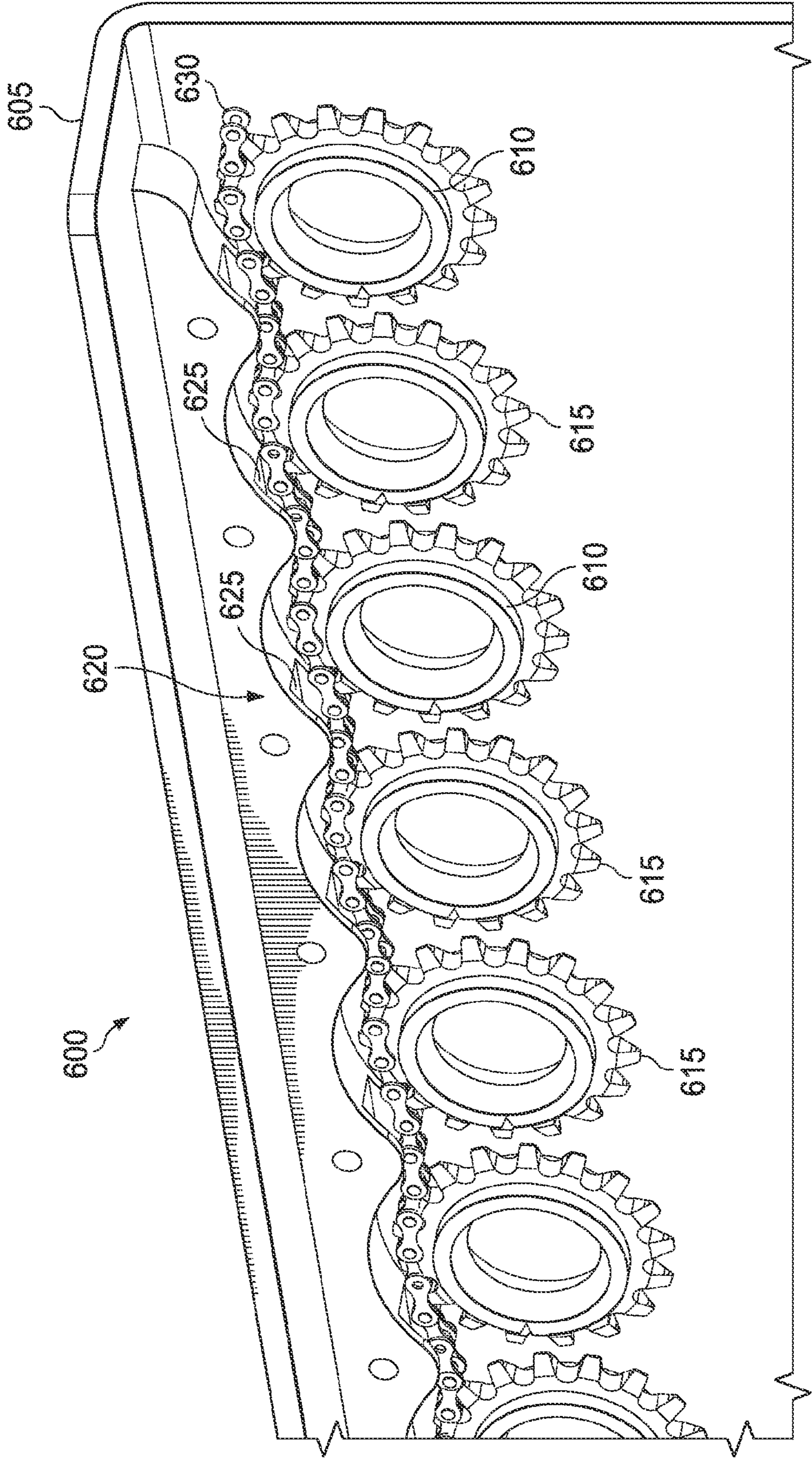


FIG. 6A

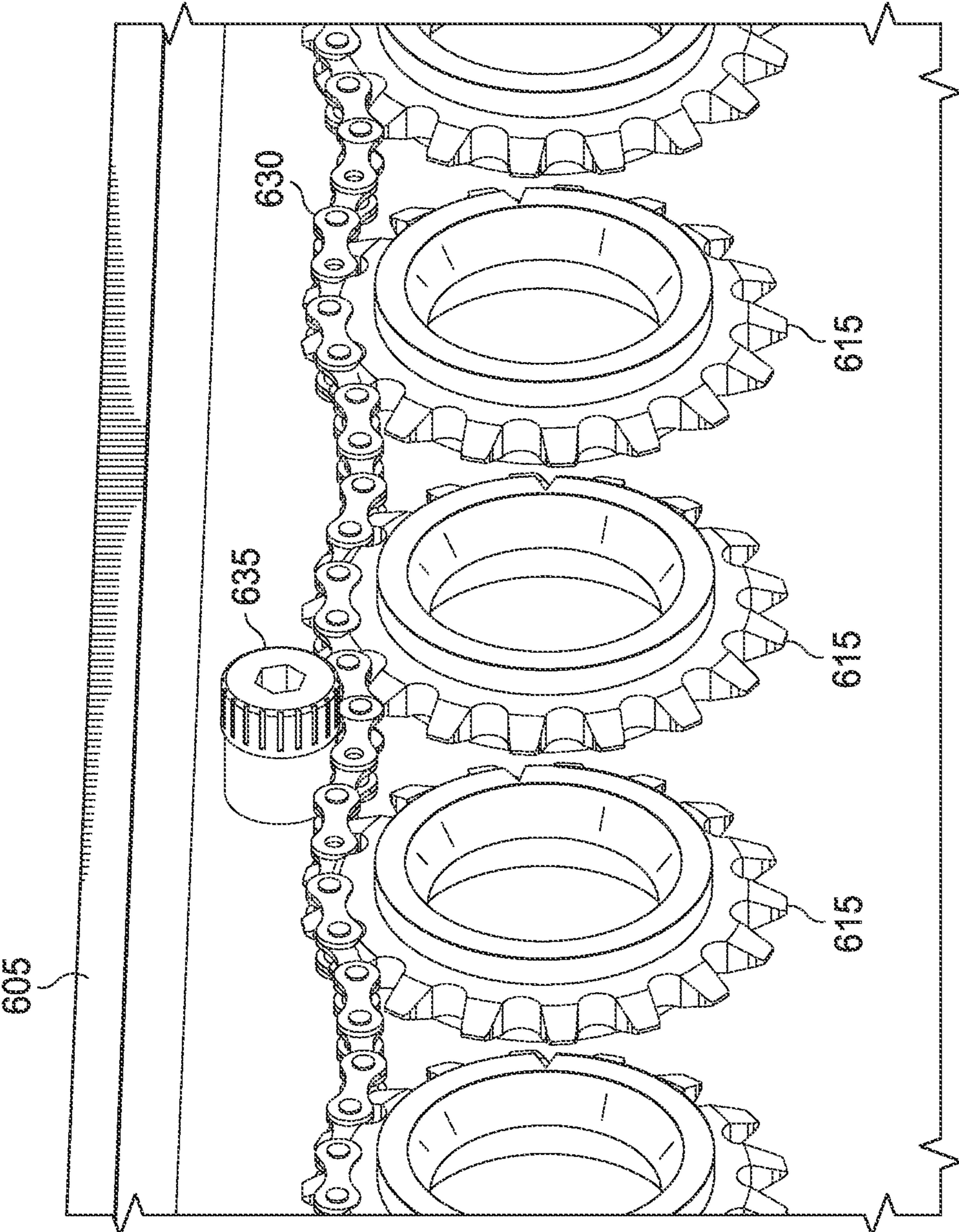


FIG. 6B

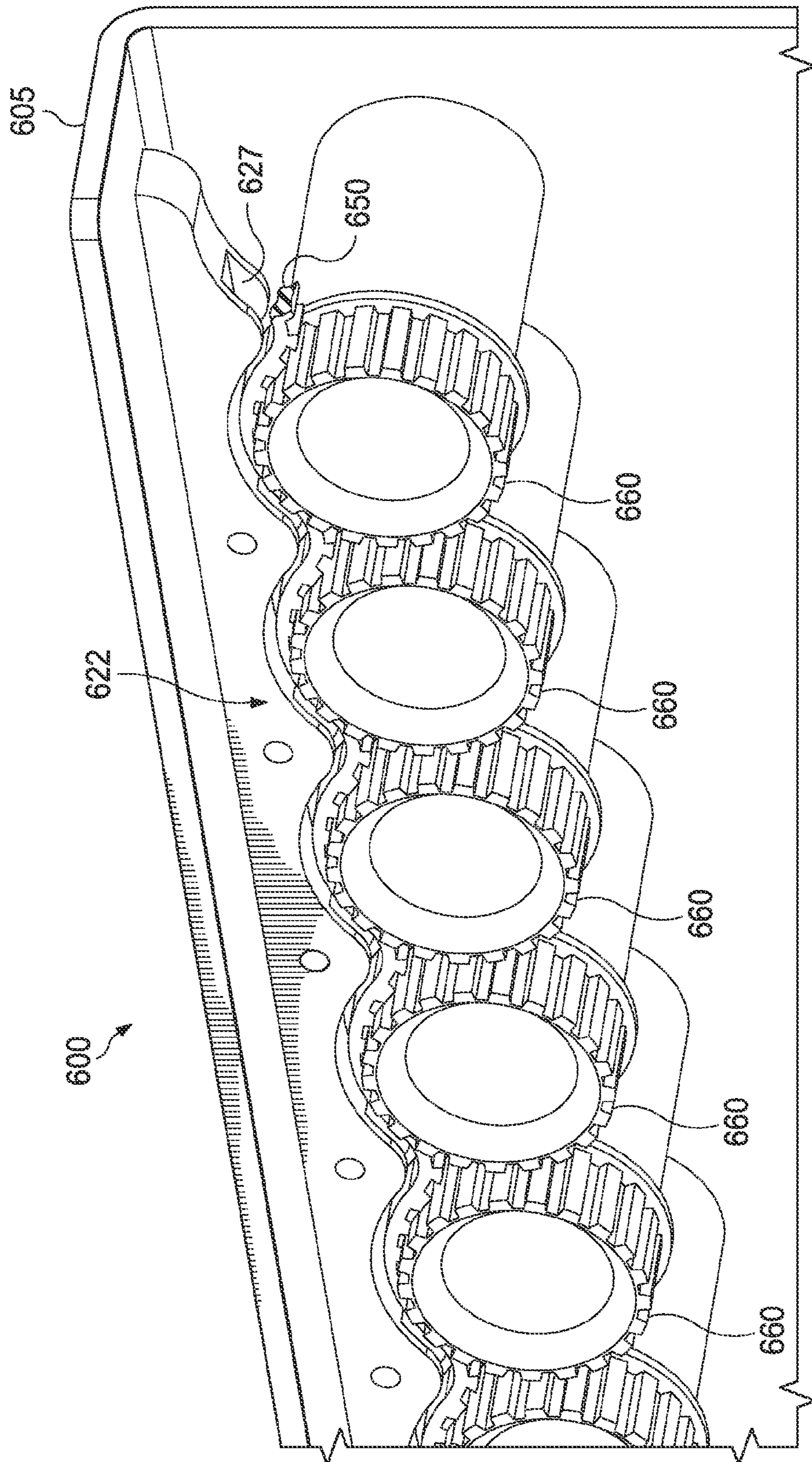


FIG. 6C

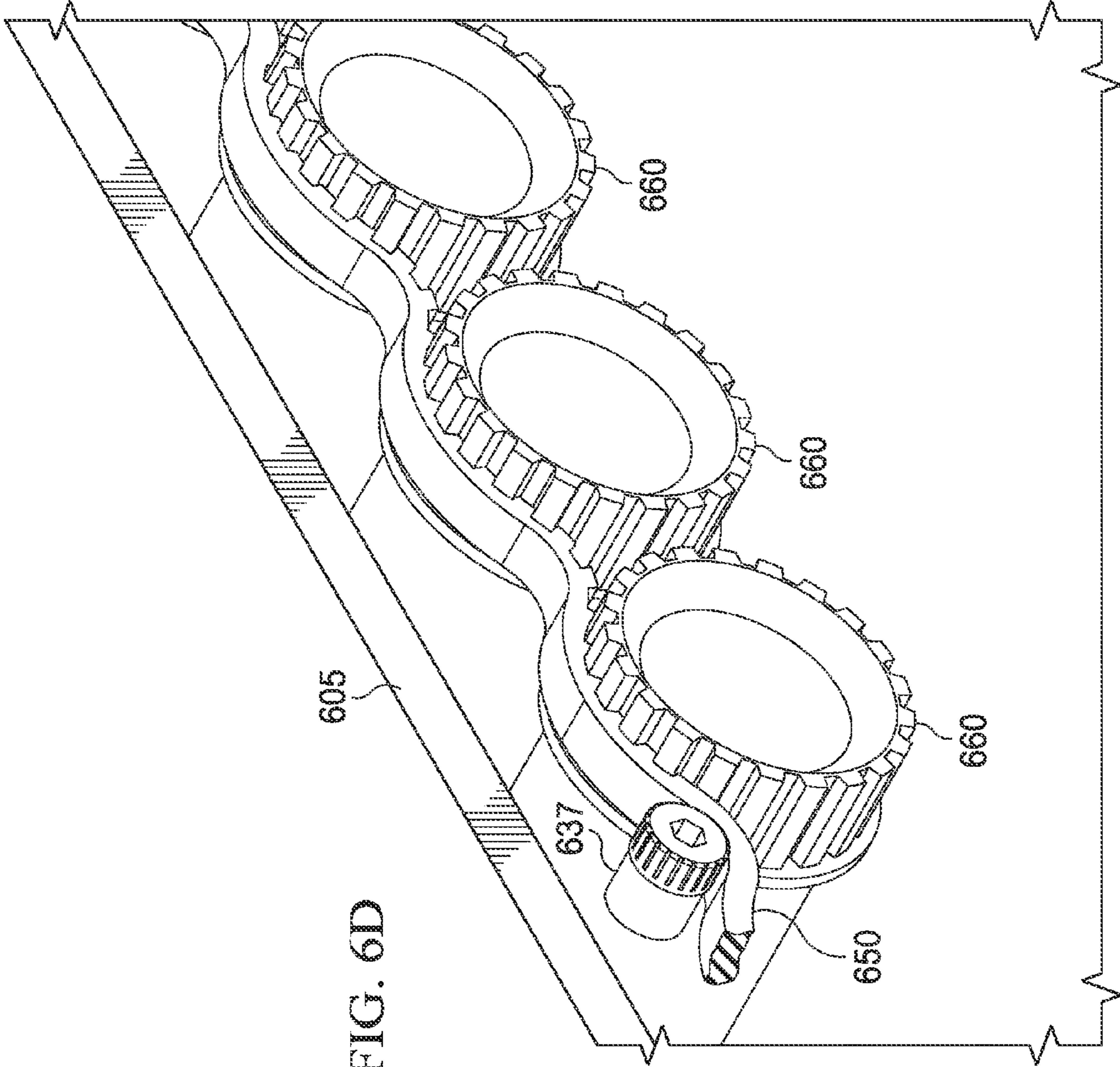


FIG. 6D

FIG. 7A

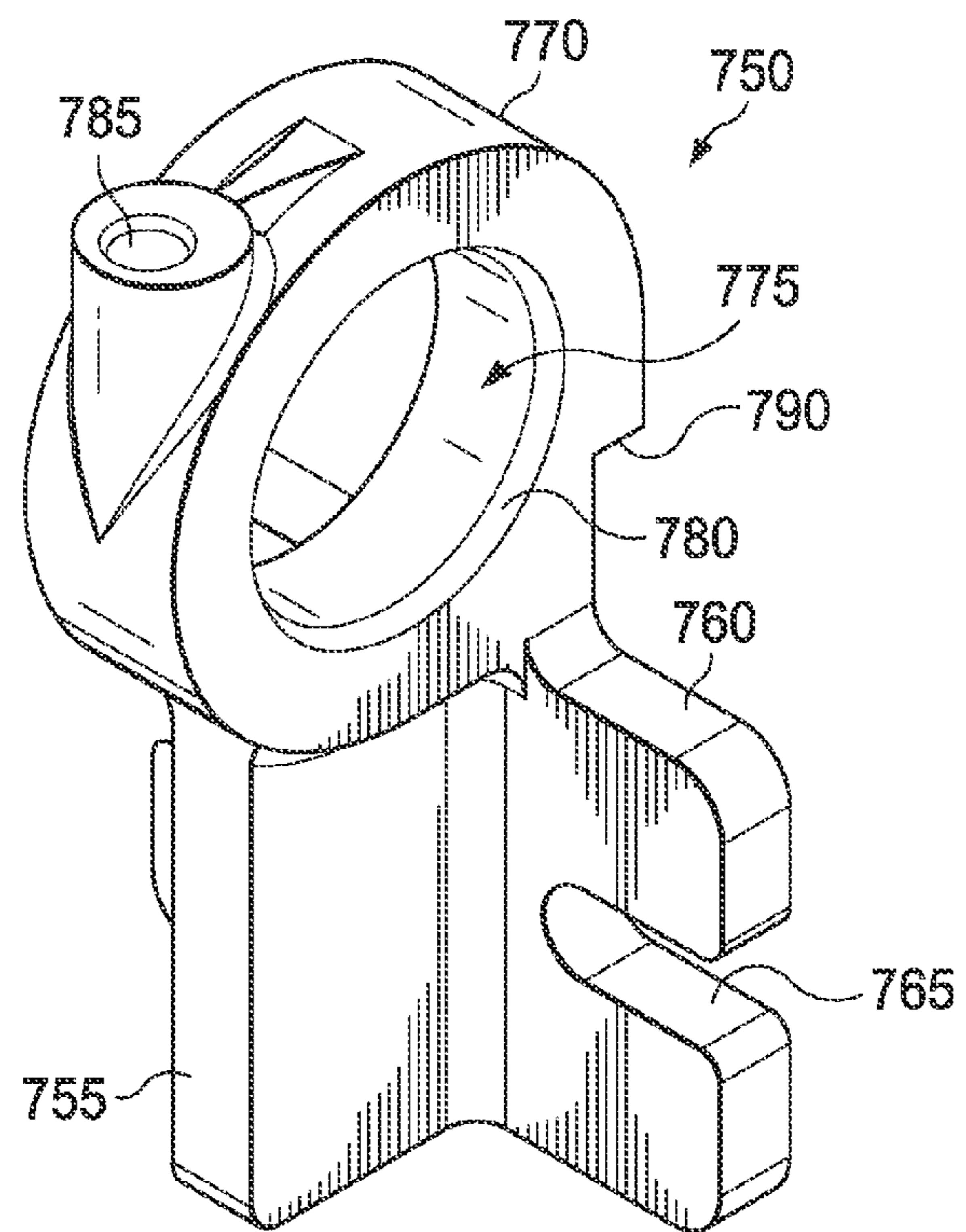
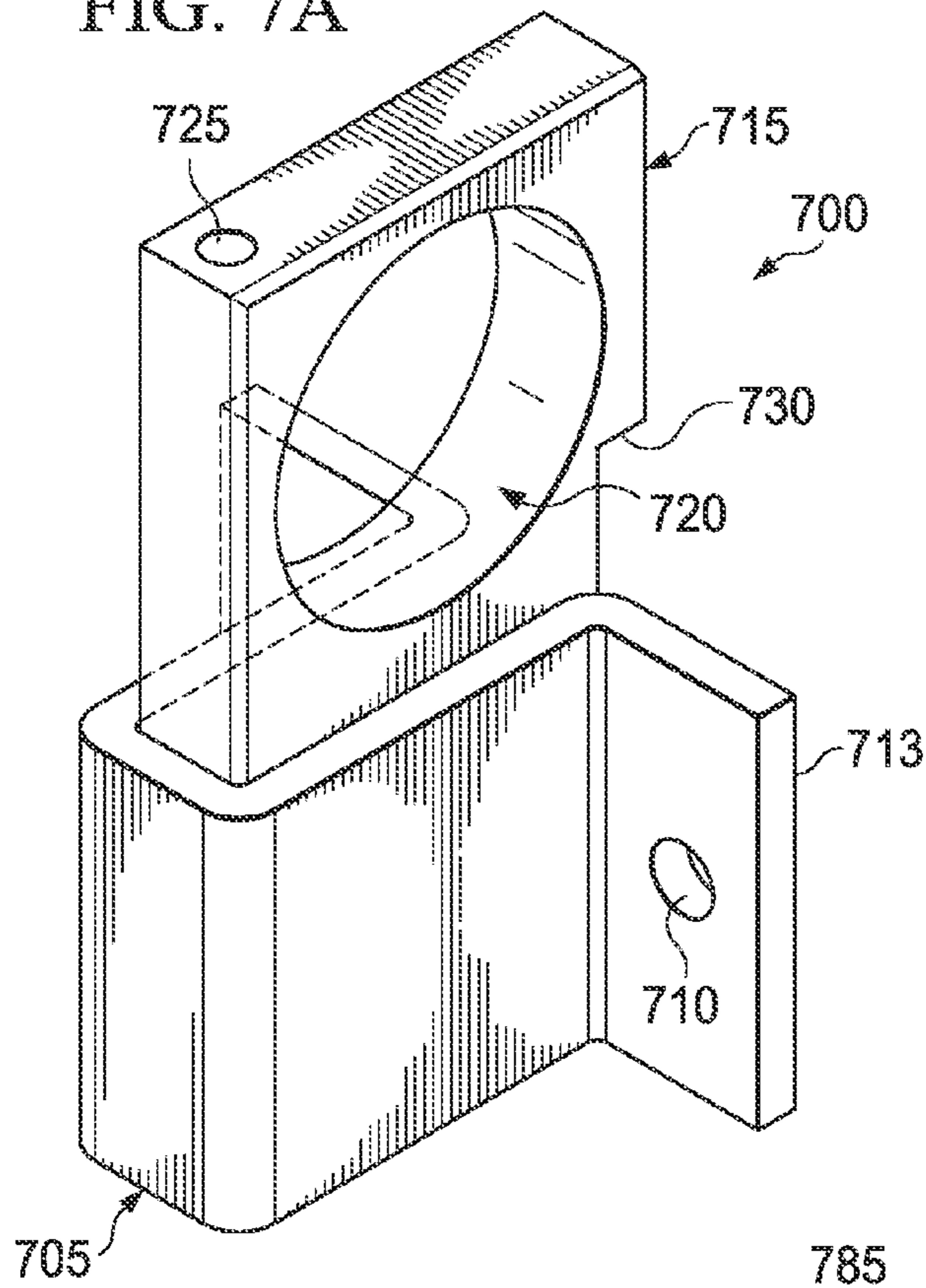


FIG. 7B

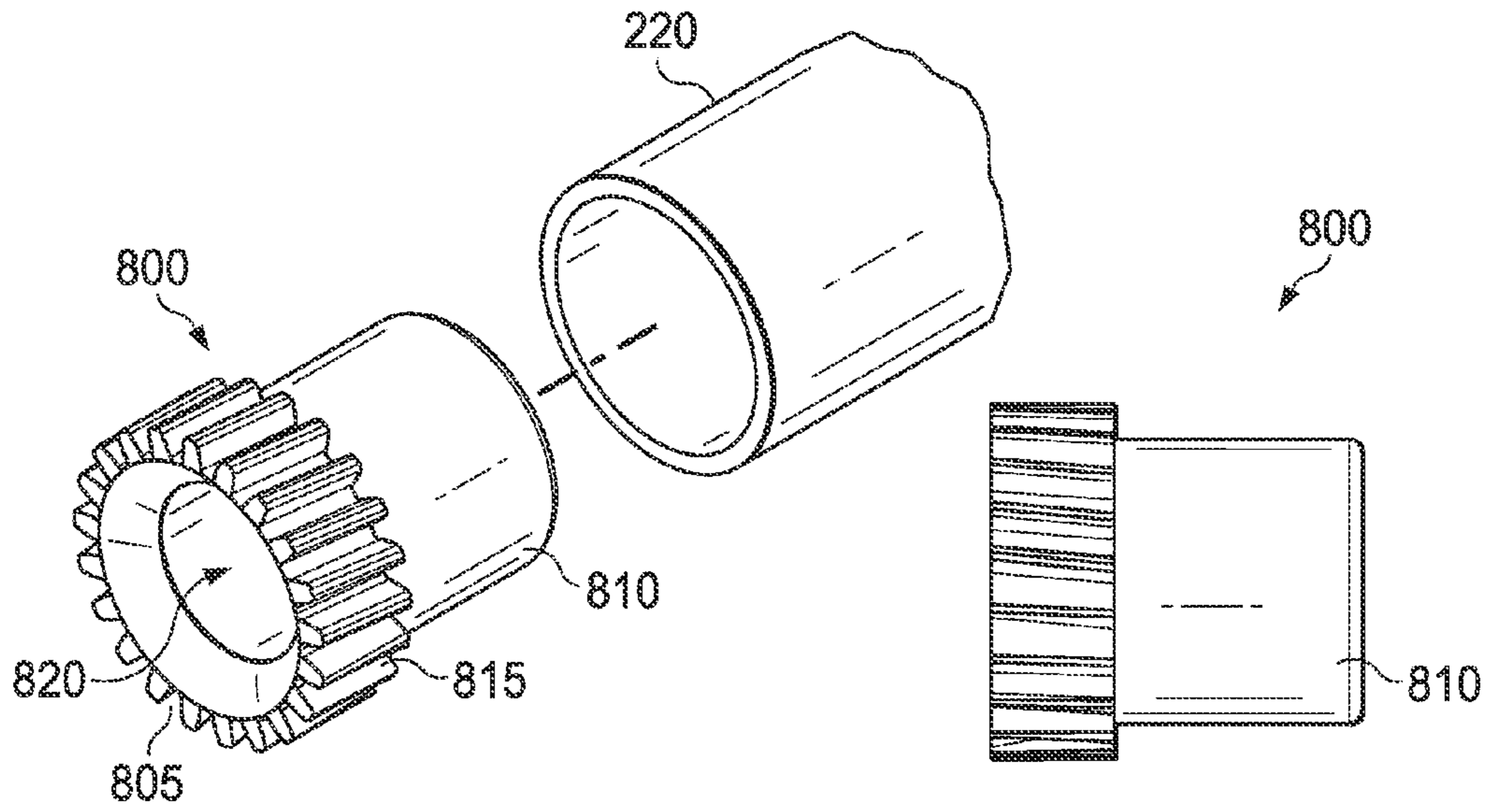


FIG. 8A

FIG. 8B

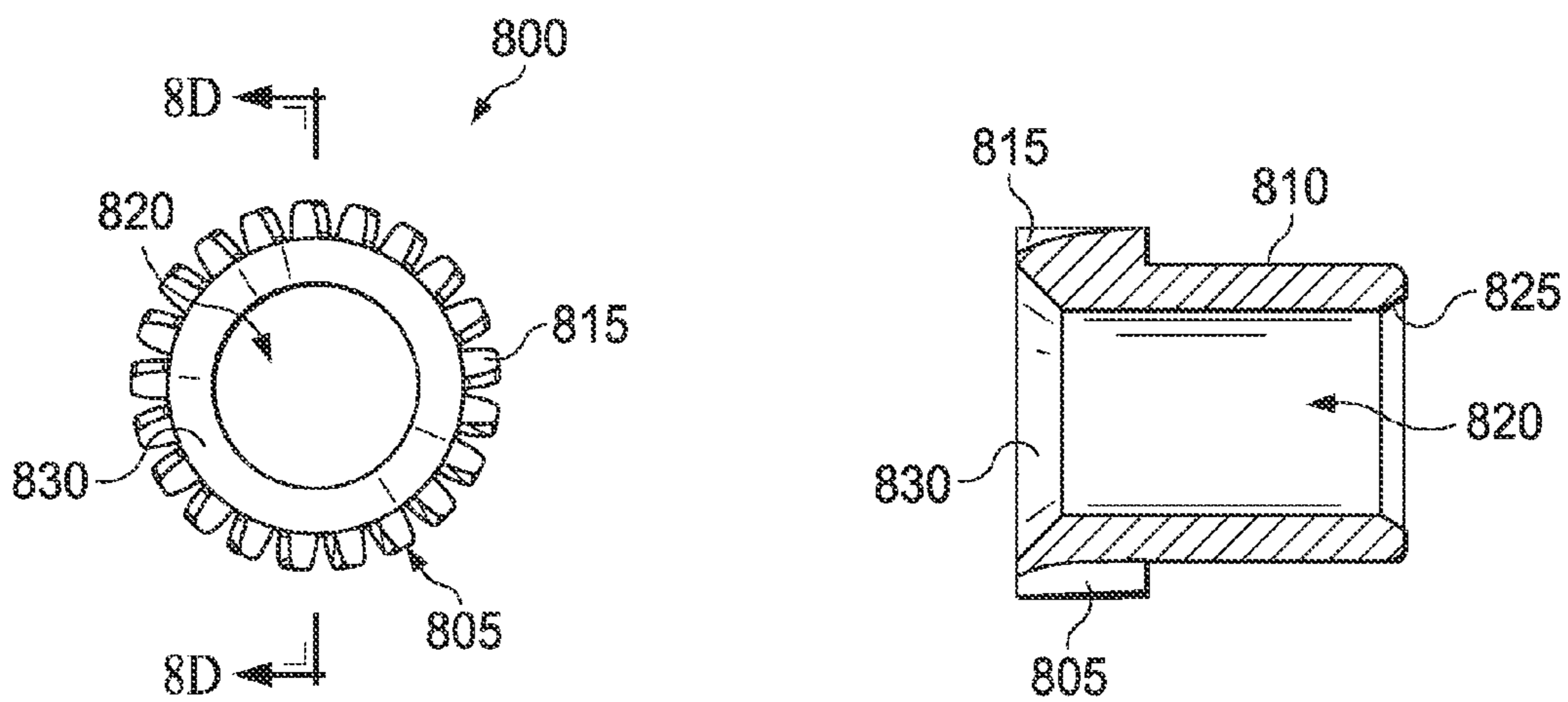


FIG. 8C

FIG. 8D

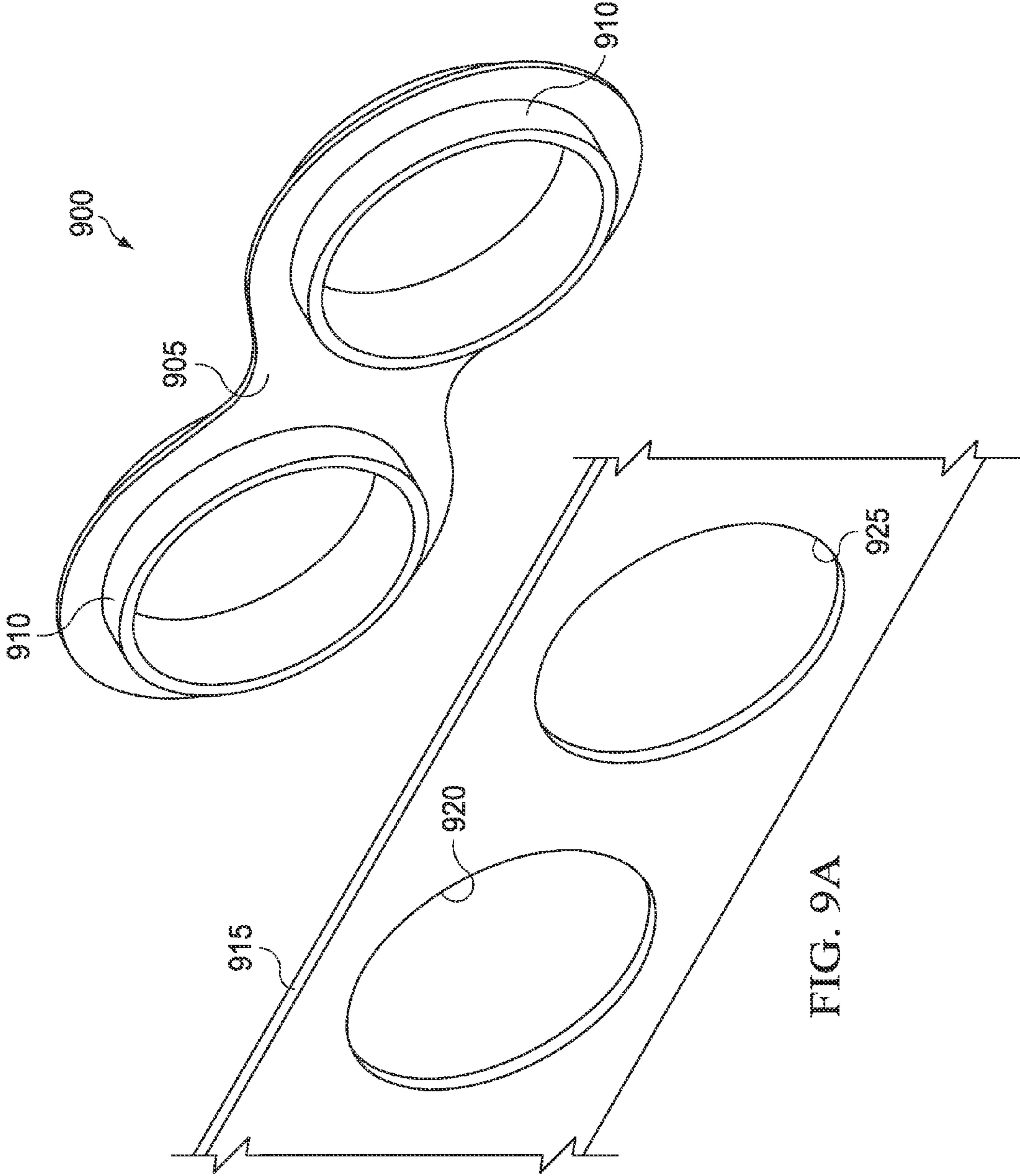
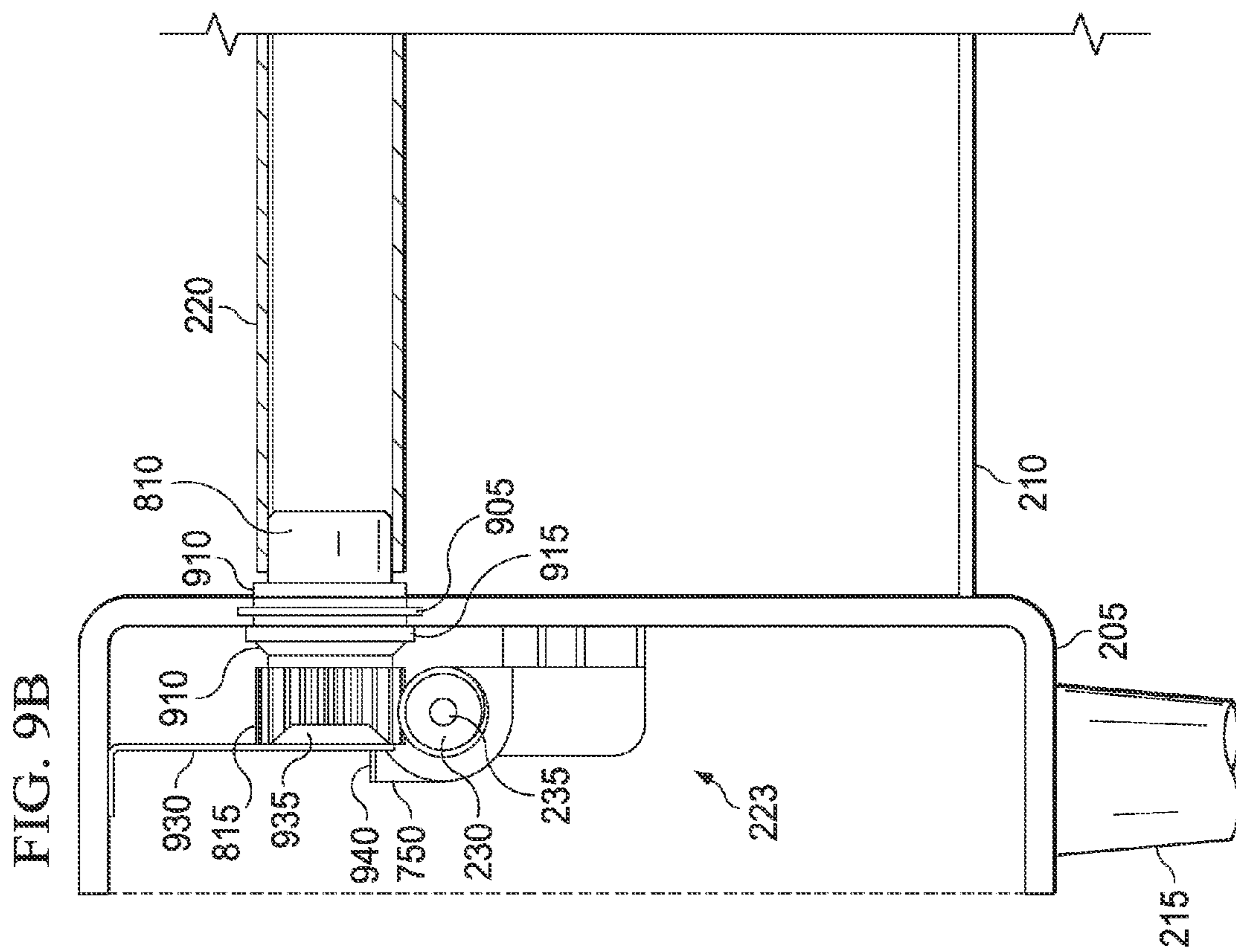


FIG. 9A



1**ROLLER GRILL**

TECHNICAL BACKGROUND

This disclosure relates to a roller grill or griddle for heating and/or reheating pre-cooked food product.

BACKGROUND

Various apparatus are used to heat and/or reheat prepared consumer pre-cooked food products. In some instances, cylindrically shaped pre-cooked food products, such as hot-dogs, tacquitos, cheese burger bites, and sausage links, may be prepared using a roller grill apparatus, which may include a number of heated, rotating tubes upon which the pre-cooked food products rest and rotate. While the heat conducting and/or radiating from the tubes and the rotation of the tubes allow the pre-cooked food products to be heated substantially uniformly, these features can also impose detrimental effects on other components of the roller grill apparatus. For example, heat conducted and/or radiated from the ends of the tubes is transferred to rotating drive mechanism components in contact with the ends of the tubes, such as chains, lubricants, bearings, and other components. The heat conducted and/or radiated through these components, as well as the mechanical engagement of these components with one another during operation of the roller grill apparatus, can cause gradual deterioration and eventual failure of such components.

Conventionally, roller grills and/or griddles used for heating and/or reheating pre-cooked food products have used chain drive assemblies to drive (e.g., rotate) tubular heating surfaces on which the pre-cooked food products may be placed. The chain drive assemblies typically utilize a metallic chain that engages metallic sprockets mounted on the tubular heating surfaces. Due in part to the metal-on-metal contact, as well as the heat energy conducted through and/or radiated from the sprockets and chain from the tubular heating surfaces (and other components of conventional roller grills), the chain drive assembly may require regular maintenance (e.g., lubrication, adjustment of the chain and/or the sprockets to maintain suitable engagement, and otherwise). Without such regular maintenance, conventional roller grills often experience high failure rates.

In some instances, pre-cooked food products must be heated to a minimum internal temperature in order to, for example, kill bacteria that can cause food related illness. For instance, certain standards (e.g., NSF International) have been established that require pre-cooked food product to be heated to a minimum internal temperature for safety reasons.

SUMMARY

In one general embodiment, a roller grill for heating a pre-cooked food product includes a housing structure adapted to support the roller grill; a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product; a plurality of rollers mounted in a row, each roller mounted on an end of a corresponding tube and including a plurality of detented projections extending from a circumferential surface of the roller; and a drive assembly. The drive assembly includes a motor including a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed; and a continuous looped surface coupled to the shaft and contactingly engaged with the detented projections of the plurality of rollers, the loop adapted to transfer the rotational power to the plurality of

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gears at a second rotational speed. The roller grill further includes a protrusion mounted to the housing structure and in contactingly engagement with the continuous looped surface, such that the continuous looped surface is contactingly engaged with at least two detented projections of each roller of the plurality of rollers mounted in the row.

In a first aspect combinable with the general embodiment, the first and second rotational speeds are substantially identical.

In a second aspect combinable with any of the previous aspects, the continuous looped surface includes a chain, and the plurality of rollers include a plurality of sprockets.

In a third aspect combinable with any of the previous aspects, the plurality of detented projections include a plurality of teeth extending from respective circumferential surfaces of the plurality of sprockets.

In a fourth aspect combinable with any of the previous aspects, the chain is contactingly engaged with the plurality of teeth.

In a fifth aspect combinable with any of the previous aspects, the chain is contactingly engaged with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

In a sixth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a chain guide having a serpentine surface contactingly guiding the chain into contactingly engagement with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

In a seventh aspect combinable with any of the previous aspects, the serpentine surface includes alternating peaked portions and recessed portions, and the chain is in contactingly engagement with the peaked portions.

In an eighth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent sprockets of the plurality of sprockets in the row.

In a ninth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a guide roller adapted to rotate about an axis, and the guide roller contactingly guides the chain into contactingly engagement with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

In a tenth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent sprockets of the plurality of sprockets in the row.

In an eleventh aspect combinable with any of the previous aspects, the continuous looped surface includes a timing belt, and the plurality of rollers include a plurality of timing pulleys.

In a twelfth aspect combinable with any of the previous aspects, the timing belt includes a plurality of teeth protruding from a surface of the timing belt, the teeth engageable with a plurality of corresponding teeth disposed on circumferential surfaces of the plurality of timing pulleys.

In a thirteenth aspect combinable with any of the previous aspects, the timing belt is contactingly engaged with at least two teeth of each timing pulley of the plurality of timing pulleys mounted in the row.

In a fourteenth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a belt guide having a serpentine surface contactingly guiding the timing belt into contactingly engagement with at least two teeth of each timing pulley of the plurality of timing pulleys mounted in the row.

In a fifteenth aspect combinable with any of the previous aspects, the serpentine surface includes alternating peaked

portions and recessed portions, and the timing belt is in contacting engagement with the peaked portions.

In a sixteenth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent timing pulleys of the plurality of timing pulleys in the row.

In a seventeenth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a guide roller adapted to rotate about an axis, and the guide roller contactingly guides the timing belt into contacting engagement with at least two teeth of each timing pulley of the plurality of timing pulleys mounted in the row.

In an eighteenth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent timing pulleys of the plurality of timing pulleys in the row.

In another general embodiment, an apparatus for heating a pre-cooked food product includes a housing structure adapted to support the apparatus; a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product; a motor including a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed; means, mounted to corresponding ends of the plurality of tubes, for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes; means, coupled to the shaft, for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes; and means, in contact with the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes, for urging the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes into contacting engagement with the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes.

In a first aspect combinable with the general embodiment, the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes is one of a chain or timing belt.

In a second aspect combinable with any of the previous aspects, the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes include a plurality of sprockets, each sprocket having a plurality of teeth extending from respective circumferential surfaces of the plurality of sprockets, and the chain is contactingly engaged with the plurality of teeth.

In a third aspect combinable with any of the previous aspects, the chain is contactingly engaged with at least two teeth of each sprocket of the plurality of sprockets.

In a fourth aspect combinable with any of the previous aspects, the means for urging the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes into contacting engagement with the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes comprises one of a chain guide or a guide roller.

In a fifth aspect combinable with any of the previous aspects, the chain guide includes a serpentine surface contactingly guiding the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets.

In a sixth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent sprockets of the plurality of sprockets.

In a seventh aspect combinable with any of the previous aspects, the guide roller contactingly guides the chain into

contacting engagement with at least two teeth of each sprocket of the plurality of sprockets.

In an eighth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent sprockets of the plurality of sprockets.

In a ninth aspect combinable with any of the previous aspects, the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes comprise a plurality of timing pulleys.

In a tenth aspect combinable with any of the previous aspects, the timing belt is contactingly engaged with at least two teeth of each timing pulley of the plurality of timing pulleys.

In an eleventh aspect combinable with any of the previous aspects, the means for urging the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes into contacting engagement with the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes comprises one of a belt guide or a guide roller.

In a twelfth aspect combinable with any of the previous aspects, the belt guide includes a serpentine surface contactingly guiding the timing belt into contacting engagement with at least two teeth of each timing pulley of the plurality of timing pulleys.

In a thirteenth aspect combinable with any of the previous aspects, the serpentine surface includes alternating peaked portions and recessed portions, and a substantially smooth surface of the timing belt is in contacting engagement with the peaked portions.

In a fourteenth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent timing pulleys of the plurality of timing pulleys.

In a fifteenth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent timing pulleys of the plurality of timing pulleys.

Various embodiments of a roller grill according to the present disclosure may include one or more of the following features. For example, the roller grill may operate in one or more selectable heating and/or reheating modes, such as a "Preparation" mode or a "Ready-to-Serve" mode. In some embodiments, the roller grill can include one or more of a cover plate and a plenum plate that serve as heat sinks by absorbing heat radiating from roller grill heating tubes and/or from drive assembly components included within the roller grill.

Various embodiments of a roller grill according to the present disclosure may also include one or more of the following features. For example, the roller grill may include a lubricator designed to clean and lubricate a drive chain included within the roller grill, such that an appropriate amount of lubricant is provided to the drive chain during operation of the roller grill. Furthermore, the lubricator may be used with any chain-driven system that needs regular lubrication maintenance, such as a bicycle chain. In some embodiments, the roller grill may have a chain glide that causes the drive chain of the roller grill to engage more than one tooth of sprockets (e.g., sprockets located between end sprockets) included within the roller grill. This multiple tooth engagement may reduce the probability of the chain being displaced from the sprockets and reducing the frictional wear on the chain and on the sprockets. In some examples, the roller grill can include rollers that increase the engagement of the drive chain with teeth on more than one sprocket at the same time.

Various embodiments of a roller grill according to the present disclosure may also include one or more of the following features. For example, the roller grill may utilize a belt drive assembly coupled to a worm gear assembly (e.g., a screw worm gear assembly) to rotate one or more heating tubes. In some examples, the cooling cycle can extend the life of the timing belt and/or provide the timing belt with a longer life as compared to a drive chain. In some examples, the cooling cycle can drop the temperature of the timing belt by up to 50° F. (10° C.). In some embodiments, the cooling cycle may provide the timing belt with a life of up to six years. In some embodiments, the roller grill may utilize a direct drive assembly, thereby eliminating belts and chains.

These general and specific embodiments may be implemented using a device, system or method, or any combinations of devices, systems, or methods. The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIGS. 1A-1E illustrate views of an example embodiment of a roller grill utilizing a direct drive assembly in accordance with the present disclosure;

FIGS. 2A-2D illustrate views of an example embodiment of a roller grill including a belt drive assembly including one or more worm gears in accordance with the present embodiments;

FIGS. 3A-3B illustrate views of another example embodiment of a roller grill utilizing a belt drive assembly in accordance with the present disclosure;

FIGS. 4A-4C illustrate views of another example embodiment of a roller grill utilizing a chain drive assembly in accordance with the present disclosure;

FIGS. 5A-5B illustrate views of example embodiments of a roller grill tube in accordance with the present disclosure;

FIGS. 6A-6D illustrate views of example embodiments of a roller grill having a chain drive assembly or a belt drive assembly according to the present disclosure;

FIGS. 7A-7B illustrate example embodiments of a bearing block that may be used to support a rotating shaft of a roller grill according to the present disclosure;

FIGS. 8A-8D illustrate an example worm gear that may be used in a roller grill according to the present disclosure; and

FIGS. 9A-9B illustrates an example bushing plate that may be used in a roller.

DETAILED DESCRIPTION

This disclosure relates to apparatus for heating and/or reheating prepared consumer pre-cooked food products, and more particularly, to roller grills and/or griddles used for heating and/or reheating cylindrically shaped pre-cooked food products, such as hotdogs and sausage links. Although in some embodiments, a roller grill according to the present disclosure may only heat and/or reheat a pre-cooked food product, in other embodiments, a roller grill according to the present disclosure may cook a raw food product.

In a general embodiment, a roller grill includes two side housings, a bottom housing, and multiple heating tubes that are disposed parallel to one another, across a volume defined between upper regions of opposite panels of the two side housings, and above the bottom housing. The heating tubes are positioned sufficiently close to one another, such that their positioning allows a pre-cooked food product to simulta-

neously rest atop two adjacent heating tubes. The heating tubes are further designed to rotate 360 degrees and have outer surfaces that are adapted to transfer heat to pre-cooked food products, thereby allowing the heating tubes to heat and/or reheat pre-cooked food products that rest atop the heating tubes.

In some embodiments, the roller grill may include a belt drive assembly having worm gears that provides rotary motion to the heating tubes. For example, the belt drive assembly can be driven by a motor that provides rotary motion to a timing belt that transfers the motion to a timing pulley, which further rotates a shaft on which worm gears are mounted and engage spur gears that are coupled to ends of the heating tubes. In some embodiments, the belt drive assembly can have timing pulleys coupled to the ends of the heating tubes and multiple idler pulleys that provide alternating heating and cooling cycles, respectively, for the timing belt during operation of the roller grill. In some examples, the timing pulleys can be maintained on the ends of the heating tubes by TEFLON™ flanges.

In some embodiments, the roller grill may include a chain drive assembly having sprockets that provides rotary motion to the heating tubes. For example, the chain drive assembly can be driven by a motor that provides rotary motion to a chain, which transfers the motion to sprockets coupled to the ends of the heating tubes. In some embodiments, the roller grill can further include a lubricator that surrounds the chain and cleans and lubricates and cools the chain substantially constantly such that an appropriate amount of lubricant is provided to the chain. In some embodiments, the roller grill can include one or both of a chain glide or multiple rollers that cause the chain to simultaneously engage more than one tooth of the sprockets, which may reduce the wear on one or both of the chain or the sprockets.

In some embodiments, the roller grill may have a direct drive assembly including a drive gear coupled to a motor and in engagement with one or more transfer gears configured to transfer rotational motion of the drive gear to matched sets of gears directly coupled to heating tubes. The gears may, in some embodiments, be spur gears. In some embodiments, the gears may be helical spur gears. In some embodiments, the gears may be non-metallic, such as, for example, a high-temperature plastic. In some embodiments, for example, one or more gears directly coupled to heating tubes may be a high-temperature plastic such as, for example, polystyrene, nylon, TEFLON™, polyethylene, polypropylene, polyvinyl chloride and polytetrafluoroethylene (PTFE), and other plastic material) that has a continual duty max temperature rating of between about 250° F. (121° C.) and about 500° F. (260° C.). In some embodiments, for example, one or more transfer and/or idler gears may be a high-temperature plastic that has a continual duty max temperature rating of between about 120° F. (49° C.) and about 200° F. (93° C.).

FIGS. 1A-1E illustrate views of an example embodiment of a roller grill **100** utilizing a direct drive assembly for heating and/or reheating pre-cooked food products, such as, for example, cylindrically shaped pre-cooked food products including hotdogs, sausage links, and other products. With reference to FIG. 1A in particular, the roller grill **100** includes two side housings **105a** and **105b** and a bottom housing **110** that is attached to and disposed between lower regions of panels of the two side housings **105a** and **105b**. The weight of the roller grill **100** is supported by multiple legs **115** that are mounted underneath and near corners of the bottom housing **110**. The roller grill **100** further includes multiple heating tubes **120** that are disposed parallel to one another, across a volume defined between upper regions of opposite panels of

the two side housings **105a** and **105b**, and above the bottom housing **110**. The heating tubes **120** are positioned sufficiently close to one another, such that their positioning allows a pre-cooked food product **125** to simultaneously rest atop two adjacent heating tubes **120**. One or more annular shaped dividers **130** may be mounted on one or more heating tubes **120** in order to prevent contact between two pre-cooked food products **125** resting atop common heating tubes **120** or to restrict lateral movement of pre-cooked food products **125** resting atop the heating tubes **120**.

In some embodiments, the roller grill **100** may be approximately 36 inches (91 cm) in total length, and the heating tubes **120** may be approximately 35.625 inches (90.488 cm) in length. In some examples, the wall thickness of a heating tube may be between approximately $\frac{5}{64}$ inches (0.20 cm) and approximately $\frac{1}{8}$ inches (0.32 cm). In some examples, the width of the roller grill **100** may depend on the number of heating tubes **120** included within the roller grill **100**. In some examples, the roller grill **100** can include multiple (e.g., 4, 8, 16, or other number) heating tubes **120**.

In some embodiments, the heating tubes **120** have outer surfaces that are adapted to transfer heat to pre-cooked food products **125** (e.g., non-stick surfaces, cleanable surfaces, or otherwise). The heating tubes **120**, in some embodiments, are further designed to rotate 360 degrees, which consequently rotates the pre-cooked food products **125** 360 degrees that are in contact with the heating tubes **120**. The heating tubes **120** may be heated by multiple electric resistive heat elements. In some embodiments, at least one of the electric resistive heat elements may be disposed within a bore of at least one of the heating tubes **120**. In some examples, the heat conducted to the surfaces of the heating tubes **120** allows them to heat and/or reheat the pre-cooked food products **125**. In some instances, the electric resistive heat elements can enable the surface temperatures of the heating tubes **120** to reach up to 300° F. (149° C.). In any event, the heating tubes **120** can heat the pre-cooked food products **125** to an internal temperature of about 160° F. (71° C.), or other temperature, to ensure that any bacteria is killed and/or eliminated.

As illustrated, the roller grill **100** may also include a drip plate **180** extending between the side housings **105a** and **105b** and underneath the heating tubes **120**. In some embodiments, the drip plate **180** may define a bottom side of a volume extending from directly underneath the heating tubes **120** to the drip plate **180** and between the side housings **105a** and **105b**. Such a volume, in some embodiments, may define a sanitary volume into which no mechanical components of the roller grill **100** (e.g., gears, motors, shafts, and other components) may extend. The drip plate **180** may, in some embodiments, be a cleanable surface that catches drippings and other solids and/or liquids from the pre-cooked food product **125**.

In some embodiments, the roller grill **100** can include a controller (not shown) that sets the roller grill **100** to operate in one or more heating modes. For example, the heating modes may include a "Preparation" mode that heats pre-cooked food products **125** to a set minimum preparation temperature (e.g., 160° F. (71° C.) internal) or a "Ready-to-Serve" mode that maintains the internal temperature of the pre-cooked food products **125** at a set serving temperature by cycling the heat on and off. In some examples, the preparation temperature of the heating tubes **120** may reach up to 300° F. (149° C.). In some examples, the serving temperature of the heating tubes **120** may reach up to 240° F. (116° C.) in order to maintain an internal pre-cooked food product temperature in the range of 140-160° F. (60-71° C.). The roller grill **100** can further be designed to operate in other heating modes

(e.g., a timed heating mode, an overnight heating mode, a "wake up" heating mode, and others).

Turning to FIGS. **1B-1E**, top, end, and side views of a portion of the roller grill **100** utilizing a direct drive assembly are illustrated. As illustrated, the roller grill **100** includes a plenums **102a** and **102b** enclosed within the side housings **105a** and **105b** in which the direct drive assembly may be disposed. The direct drive assembly may drive (e.g., rotate) the heating tubes **120** to heat and/or reheat pre-cooked food product. As illustrated, each heating tube **120** is installed over a tubular portion of a heating tube gear **140**, which in turn, is installed through apertures in the side housing **105**. A bushing **135a** may also be installed through the aperture of the side housing **105** such that the heating tube **120** is disposed within the bushing **135a** and may move (e.g., rotate) within the bushing **135a**. In some embodiments, as illustrated in FIG. **9A**, the bushing **135a** may be a paired bushing, such that two heating tubes **120** are inserted through a single bushing **135a**.

In the illustrated embodiment, a plenum plate **155** may be installed in the plenum **102a** and to a surface of the side housing **105**. As illustrated, the plenum plate **155** may extend substantially an entire width of the plenum **102a** (as shown in FIG. **1C**) and from a bottom edge of the plenum **102a** to just above a midpoint of one or more idler gears **145**. In some embodiments, the idler gears **145**, as well as one or more transfer gears **160**, may be mounted to the plenum plate **155**. For instance, the gears **145** and **160** may be mounted through a mechanical fastener disposed through an axis of the particular gear and through the plenum plate **155**. In alternative embodiments, studs may be mounted (e.g., welded) on to the plenum plate **155** over which the gears **145** and **160** may be mounted. In any event, the gears **145** and **160** may be free-spinning gears mounted to the plenum plate **155** without penetrations through the side housing **105** (e.g., into a sanitary volume below the pre-cooked food product **125**).

In the illustrated embodiment of the roller grill **100**, the plenum plate **155** include one or more ventilation holes **195** that allow fluid (e.g., airflow) communication between the plenum **102a** and a volume defined between the bottom housing **110** and the drip plate **180** and also defined between the side housing **105**. In some embodiments, airflow may be circulated between the plenum **102a** and an ambient airspace through, for example, the ventilation holes **195** and one or more louvered openings in the bottom housing **110**.

In the illustrated embodiment, a retainer plate **190a** (e.g., the retainer plate **915** shown in FIG. **9A**) may be mounted over the bushing **135a** through attachment (e.g., mechanical) with the side housing **105**. The retainer plate **190a** may sandwich the bushing **135a** against the side housing **105**, thereby preventing (all or partially) rotational movement of the bushing **135a** during movement (e.g., rotation) of the heating tubes **120**.

FIG. **1B** illustrates heating elements **150a** (e.g., heaters with spade terminals) to which wires may be coupled and thereby electrically coupled to a power source. The heating elements **150a** may, in some embodiments, be an electric resistance heater installed through the heating tube **120** (e.g., all or partially) that may generate heat power to increase a temperature of an outer surface of the heating tube **120**. In some embodiments, each heating tube **120** may include an individual heating element **150a**. Alternatively, heating elements **150a** may be installed in every other heating tube **120** (e.g., alternating heating tubes **120**) or otherwise.

In the illustrated roller grill **100**, the idler gears **145** are mounted below and engaged with the heating tube gears **140**. Further, the illustrated roller grill **100** includes a drive gear **165** disposed on a shaft **170** of a motor **175** including a fan **178**

(shown in FIG. 1D) that may be mounted in a bottom cavity of the roller grill 100 (defined by the side housings 105a and 105b, the drip plate 180, and the bottom housing 110). The drive gear 165 contactingly engages a transfer gear 160 within a series of transfer gears 160 to transfer rotational motion of the shaft 170 to the transfer gears 160. Although three transfer gears 160 are illustrated in FIG. 1C, alternative embodiments may include more or fewer transfer gears 160. In some embodiments, one or more of the transfer gears 160 may be helical spur gears (e.g., helical gear 800).

As illustrated, one of the transfer gears 160 may be engaged with one or more of a plurality of idler gears 145 disposed across a width of the side housing 105. As illustrated, the idler gears 145 may be spaced evenly across the plenum plate 155. The roller grill 100 also includes heating tube gears 140 that are coupled (e.g., inserted into) to respective heating tubes 120. For example, as illustrated, there may be a 1:1 ratio of heating tube gears 140 and heating tubes 120. In some embodiments, one or more of the idler gears 145 and/or heating tube gears 140 may be helical spur gears (e.g., helical gear 800).

As illustrated, a cover plate 185a may be disposed in the plenum 102a and mounted to a top interior surface of the side housing 105. In some embodiments, the cover plate 185a may cover ends of the heating tube gears 140. In some embodiments, the cover plate 185a may be mounted adjacent a gear head portion of the heating tube gear 140 such that a concave portion extends into the gear head portion adjacent a beveled surface (e.g., as shown in FIG. 9B). In some embodiments, electrical wiring coupled to the respective heating elements 150a inserted through the heating tube 120 may be installed within a volume defined by the concave portion, thereby saving space within the plenum 102a.

The gears 140, 145, 160, and 165 may, in some embodiments, be spur gears. In some embodiments, the gears 140, 145, 160, and 165 may be helical spur gears. In some embodiments, the gears 140, 145, 160, and 165 may be non-metallic, such as, for example, a high-temperature plastic. In some embodiments, for example, one or more gears 140 may be a high-temperature plastic such as, for example, polystyrene, nylon, TEFLON™, polyethylene, polypropylene, polyvinyl chloride, polytetrafluoroethylene (PTFE), and other plastic material) that has a continual duty max temperature rating of between about 250° F. (121° C.) and about 500° F. (260° C.). In some embodiments, for example, one or more gears 145, 160, and/or 165 may be a high-temperature plastic that has a continual duty max temperature rating of between about 120° F. (49° C.) and about 200° F. (93° C.).

In some embodiments, the gears 140, 145, 160, and 165 (and other rollers described herein, such as gears 225 and 230 and pulleys 325a, 330a, as some examples) may be self-lubricating. For example, in some embodiments having non-metallic gears 140, 145, 160, and 165, a material that forms the gears 140, 145, 160, and 165 may be impregnated with or otherwise contain a lubricant material, such as, for example, silicon, or other lubricant material. During operation of the roller grill 100, the lubricant material may exude from one or more of the gears 140, 145, 160, and 165, thereby providing for decreased failure rates due to lack of lubricant between the gears 140, 145, 160, and 165 and other components (e.g., chains, belts, or other components).

Turning to FIG. 1E, a side view of a non-drive side of the roller grill 100 is illustrated. In some embodiments, only one side housing 105a may enclose (at least partially) one or more gears and other components of the direct drive assembly. In alternative embodiments, both side housings 105a and 105b may enclose (at least partially) a portion of one or more (e.g.,

two) direct drive assemblies as described above. For example, there may be two motors 175 with each motor 175 driving (e.g., rotating) half of a total number of heating tubes 120 via independent direct drive assemblies. Each independent direct drive assembly may be enclosed within separate side housings 105a and 105b.

As illustrated, one of the plenums 102b enclosed by the side housing 105b (shown in FIG. 1E) is substantially free of gears and other direct drive assembly components. As illustrated, the heating tube 120 may include heating element 150b extending from this end of the tube 120 and may extend through the side housing 105b and be secured to the side housing 105b by a bushing 135b (as described above). The bushing 135b may be sandwiched against an interior surface of the side housing 105b by a retainer plate 190b (as described above). In the illustrated embodiment, a cover plate 185b is mounted to the side housing 105b and adjacent the bushing 135b. In some embodiments, a bearing 197 may be mounted between the bushing 135b and the retainer plate 190b so as to, for example, provide a bearing (e.g., wear) surface between the bushing 135b and the retainer plate 190b.

In operation, the motor 175 of the roller grill 100 may rotate the shaft 170, which in turn rotates the drive gear 165. The drive gear 165, in turn, transfers rotational movement to the transfer gears 160. One of the transfer gears 160 is engaged with one or more of the idler gears 145 such that rotational movement is transferred from the transfer gears 160 to the engaged idler gear 145. The engaged idler gear 145 is also in contacting engagement with at least one of the heating tube gears 140, and transfers rotational movement to the at least one heating tube gear 140. Rotational movement is thus transferred to each of the idler gears 145 and heating tube gears 140, thereby rotating the heating tubes 120.

FIGS. 2A-2D illustrate views of an example embodiment of a roller grill 200 including a belt drive assembly including one or more worm gears. FIG. 2A shows that the roller grill 200 includes a side housing 205 and a bottom housing 210 that is attached to and disposed between lower regions of plates of the side housing 205 and a corresponding side housing on an opposite end of the roller grill 200 (not shown). Referring now to FIG. 2B, the weight of the roller grill 200 is supported by multiple legs 215 that are mounted underneath and near corners of the bottom housing 210.

FIGS. 2A-2B illustrate the roller grill 200 further including multiple heating tubes 220 that are disposed parallel to one another, across a volume defined between upper regions of opposite panels of the two side housings 205, and above the bottom housing 210. An end of each heating tube 220 extends through a respective hole within the panel of the side housing 205 into a plenum space 223 provided by the side housing 205. In some embodiments, the width of the plenum space 223 is approximately 1.625 inches (4.128 cm). Within the plenum space 223, each heating tube 220 and is engaged with a respective spur gear 225 included within the belt drive assembly. In some examples, each spur gear 225 is mounted in the end of the respective heating tube 220 and is maintained on the end by a respective bushing 250 and/or other components. In some examples, the spur gears 225 may be helical spur gears. Within the plenum space 223, the spur gears 225 are further engaged with worm gears 230 disposed adjacent (e.g., beneath) the spur gears 225 and mounted on a shaft 235 that extends along at least a portion of the width of the roller grill 200.

In some embodiments, the ratio of spur gears 225 to worm gears 230 is 1:1. In some embodiments, the ratio of spur gears 225 to worm gears 230 is 2:1 or another ratio. In some embodiments, a spur gear 225 may be a helical spur gear. In

some embodiments, a worm gear **230** may be a screw worm gear. In some embodiments, the shaft **235** may be coupled to the side housing **205** by one or more bearing blocks **260**.

FIG. 2C illustrates that the shaft **235** is further coupled to a timing pulley **240** having multiple teeth disposed on a cylindrical surface that engage multiple teeth protruding from a surface of a timing belt **245**. The timing belt **245** sequentially engages multiple components of the belt drive assembly that may be fully or partially disposed within the bottom housing **210** of the roller grill **200**. For example, such components include, as illustrated, a first pulley **255**, a timing gear **270** having multiple teeth disposed on a circumferential surface and mounted on a shaft of a motor **265**, and a second pulley **275** disposed vertically higher than the first pulley **255**. In some examples, one or both of the pulleys **255** or **275** can be a timing pulley (i.e., with a grooved circumferential surface). In some examples, one or both of the pulleys **255** or **275** may have substantially smooth outer cylindrical surfaces.

During operation of the roller grill **200**, the motor **265** generates rotary motion of the heating tubes **220** by using the timing belt **245** to transfer rotary motion to the worm gears **230** engaged with the spur gears **225**. Power generated by the motor **265** drives rotation of the timing gear **270** mounted on the shaft of the motor **265**, which, by engagement of the teeth disposed on the surface of the timing gear **270** with the teeth protruding from the surface of the timing belt **245**, drives rotation of the timing belt **245**. Thus, in the illustrated embodiment, the timing belt **245** extends from the bottom housing **210** through the panel of the side housing **205** and into the plenum space **223** provided by the side housing **205** to engage the timing pulley **240**. Alternatively, the motor **265** may be mounted elsewhere in or on the roller grill **200** (e.g., in the plenum space **223** or otherwise).

Engagement of the teeth protruding from the surface of the timing belt **245** with teeth disposed on the surface of the timing pulley **240** drives rotation of the timing pulley **240**, which in turn rotates the shaft **235**. Rotary motion of the shaft **235** drives rotation of the worm gears **230**, which consequently drives rotation of the spur gears **225** due to their engagement with the worm gears **230**, and further drives rotation of the heating tubes **220** that are coupled to the spur gears **225**.

In some embodiments, one motor **265** may be coupled to two belt drive assemblies located at opposing sides of the roller grill **200**. In some embodiments, a first motor **265** may be coupled to a first belt drive assembly located at a first side of the roller grill **200**, while a second motor **265** may be coupled to a second belt drive assembly located at a second side of the roller grill **200**. In other embodiments, there may be two (or more) belt drive assemblies, with each assembly driving a subset of a total number of heating tubes **220** of the roller grill **200**. Each belt drive assembly may drive the corresponding subset of heating tubes **220** from the same end of the roller grill **200** or from opposed ends.

Referring now to FIG. 2D, in some embodiments, a cover plate **280** may be attached to the side housing **205**, such that the cover plate **280** is adjacent to the spur gears **225** and the worm gears **230**. The cover plate **280** is disposed to cover various components of the drive assembly (i.e., spur gears **225**, worm gears **230**, and other components) and is visible when the side housing **205** is displaced from the roller grill **200**. The cover plate **280** may further serve as a heat sink that absorbs heat radiated from the heating tubes **220** and/or the drive assembly components, thereby transferring heat away from the drive assembly components and transferring heat to, for example, the plenum space **223** provided the side housing **205** or an ambient space exterior to the roller grill **200**.

FIGS. 3A-3B illustrate views of another example embodiment of a roller grill **300** utilizing a belt drive assembly. The roller grill **300** includes a side housing **305** and a bottom housing **370** that is attached to and disposed between lower regions of panels of the side housing **305** and a corresponding side housing on an opposite end of the roller grill **300** (not shown). The weight of the roller grill **300** is supported by multiple legs **310** that are mounted underneath and near ends of the bottom housing **370**. The roller grill **300** further includes multiple heating tubes **355** that are disposed parallel to one another, across a defined volume between upper regions of opposite panels of the two side housings **305**, and above the bottom housing **370**. The heating tubes **355** are further positioned sufficiently close to one another so as to allow a pre-cooked food product **365** to simultaneously rest atop two adjacent heating tubes **355**. One or more annular shaped dividers **360** may be mounted on each heating tube **355** in order to prevent contact between two pre-cooked food products **365** positioned along common heating tubes **355** or to restrict lateral movement of a pre-cooked food product **365** resting atop the heating tubes **355**.

In some embodiments, an end of each heating tube **355** extends through a respective hole within the panel of the side housing **305** into a plenum space **357** provided by the side housing **305**, where the heating tubes **355** are coupled to one or more belt drive assemblies. In this example, the roller grill **300** includes two belt drive assemblies, a first belt drive assembly **301a** and a second belt drive assembly **301b**. In alternative embodiments, however, the roller grill **300** may include only one belt drive assembly or multiple (e.g., two or more) belt drive assemblies. The first belt drive assembly **301a** includes, as illustrated, a timing belt **315a**, multiple timing pulleys **325a**, multiple upper idler pulleys **330a**, two lower idler pulleys **340a**, a tensioning pulley **335a**, and a timing gear **345a**. However, in alternative embodiments, the first belt drive assembly **301a** may include more or fewer of these listed components. The second belt drive assembly **301b** includes, as illustrated, a timing belt **315b**, multiple timing pulleys **325b**, multiple upper idler pulleys **330b**, two lower idler pulleys **340b**, a tensioning pulley **335b**, and a timing gear **345b**. However, in alternative embodiments, the second belt drive assembly **301b** may include more or fewer of these listed components.

In the illustrated embodiment, the timing belts **315a** and **315b** include teeth protruding from a circumferential surface that are adapted to engage teeth disposed on a surface of one or more corresponding timing pulleys **325a**, **325b**. The timing belts **315a** and **315b** are secured on the one or more corresponding timing pulleys **325a** and **325b** by one or more bushings **320a** and **320b**. Alternatively, one or both of the timing belts **315a** and **315b** may be smooth belts, with no teeth or other protrusions on a circumferential surface.

In some embodiments, the teeth protruding from a first surface of the timing belt **315a**, **315b** engage the teeth disposed on the surface of one or more timing pulleys **325a**, **325b** alternate with a second surface of the timing belt **315a**, **315b** engaging one or more upper idler pulleys **330a**, **330b**. Following engagement of the timing belt **315a**, **315b** with the one or more timing pulleys **325a**, **325b** and the one or more upper idler pulleys **330a**, **330b**, the teeth protruding from the surface of the timing belt **315a**, **315b** engage teeth disposed on a surface of a tensioning pulley **335a**, **335b**, which may be mounted on a vertically adjustable, spring-loaded bracket assembly **343a**, **343b**. The bracket assembly **343a**, **343b** allows the tensioning pulley **335a**, **335b** to be adjusted vertically, thereby further allowing adjustment of tension in the

timing belt **315a**, **315b**. In some embodiments, the roller grill **300** may not include the tensioning pulley **335a**, **335b** and the bracket assembly **343a**, **343b**.

In some embodiments, the belt drive assemblies **301a** and **301b** can include one or more lower idler pulleys **340a**, **340b**. Following engagement of the teeth protruding from the surface of the timing belt **315a**, **315b** with the teeth disposed on the surface of the tensioning pulley **335a**, **335b**, the teeth protruding from the surface of the timing belt **315a**, **315b** engage teeth disposed on the surface of the timing gear **345a**, **345b**. The timing gear **345a**, **345b** may be coupled to a motor (not shown) located in the bottom housing **370** of the roller grill **300** that drives rotary motion of the timing belt **315a**, **315b**.

In some embodiments, one or more of the upper idler pulleys **330a**, **330b** may be coupled to a plenum plate **350**, which can serve as a heat sink that transfers heat away from the timing belt **315a**, **315b** and timing pulleys **325a**, **325b**.

In some embodiments, a louver **375** may be disposed along the bottom surface of the bottom housing **370**, allowing cool air to pass into the bottom housing **370** and cool the motor and any other drive components disposed within the bottom housing.

Referring now to FIG. 3B, in some embodiments, a plenum plate **380** may be attached to each side housing **305**. Various components of the drive assembly, such as, for example, the timing gears **345a** and **345b**, the idler pulleys **340a** and **340b**, and other components, may be mounted on (e.g., via mechanical fasteners) on the plenum plate **380**. The plenum plate **380** may further serve as a heat transfer surface that absorbs heat radiated from the heating tubes **355** and the drive assembly components, thereby transferring heat away from the drive assembly components. In some embodiments, the plenum plate **380** may include one or more ventilation holes **395** allowing fluid (e.g., airflow) communication between the plenum **357** and a volume defined underneath the heating tubes **355** and within the bottom housing **210**. Such airflow may also be communicated through the louvers **375**. The roller grill **300** may also include multiple bushings **390** that are respectively mounted over the ends of the multiple heating tubes **355** and that, for example, prevent the timing pulleys **325a**, **325b** from moving inward on the multiple heating tubes **355**. Further, the bushings **390**, which may be similar to, for instance, the bushing **900** shown in FIG. 9A, may provide a bearing surface for the heating tubes **355** to rotate within during operation of the roller grill **300**. In some examples, the plenum plate **380** may have a thermal conductivity that is greater than or equal to 200 Btu/(hrft² F.) (346 W/(mK)) at a temperature of 250° F. (121° C.).

During operation of the roller grill **300**, one or more motors (located within the bottom housing **370**, not shown in FIGS. 3A-3B) drive rotation of the heating tubes **355** via the belt drive assemblies **301a**, **301b**. In some embodiments, a single motor may drive both belt drive assemblies **301a**, **301b**. In other embodiments, each belt drive assembly **301a**, **301b** (and other belt drive assemblies), may each be driven by a dedicated motor.

Power generated by the motor drives rotation of the timing gear **345a**, **345b** mounted on a shaft (not shown in FIGS. 3A-3B) of the motor, which, by engagement of the teeth protruding from the surface of the timing belt **315a**, **315b** with teeth disposed on the surface of the timing gear **345a**, **345b**, drives rotary motion of the timing belt **315a**, **315b**. Engagement of teeth protruding from the surface of the timing belt **315a**, **315b** with teeth disposed on the surface of the timing pulleys **325a**, **325b** further provides rotary motion to the timing pulleys **325a**, **325b**, which consequently rotate the

heating tubes **355**. Engagement of the teeth protruding from the timing belt **315a**, **315b** with teeth and surface of the timing belt **315a**, **315b** disposed on the surface of the idler pulleys **330a**, **330b**, **340a**, **340b** and the tensioning pulley **335a**, **335b**, further rotates the idler pulleys **330a**, **330b**, **340a**, **340b** and the tensioning pulley **335a**, **335b**, respectively.

In some embodiments, the arrangement of the timing pulleys **325a**, **325b** and one or more of the idler pulleys **330a**, **330b**, **340a**, **340b**, the tensioning pulley **335a**, **335b**, and the timing gear **345a**, **345b** creates a series of alternating timing belt heating cycles and timing belt cooling cycles, respectively. In some embodiments, the timing belt heating cycles are provided by heat radiated from the timing pulleys **325a**, **325b**. When heat is generated within the heating tubes **355** by, for example, electric resistive heating elements, the heat is transferred to various components of the roller grill assembly **300**, including the bushings **390** and the timing pulleys **325a**, **325b**. As the timing belt **315a**, **315b** engages with the timing pulleys **325a**, **325b**, the timing belt **315a**, **315b** absorbs heat from the timing pulleys **325a**, **325b** (i.e., the timing pulleys **325a**, **325b** transfer heat to the timing belt **315a**, **315b**).

In some embodiments, the timing belt **315a**, **315b** may be made from low heat conducting material. For example, the timing belt **315a**, **315b** may be insulated from the transfer of heat from, for instance, the heating tubes **355** through the timing pulleys **325a**, **325b**.

In some embodiments, the timing belt cooling cycles are provided by heat absorbed by one or more of the idler pulleys **330a**, **330b**, **340a**, **340b**, the tensioning pulley **335a**, **335b**, and the timing gear **345a**, **345b**. For example, as the timing belt **315a**, **315b** engages with the idler pulleys **330a**, **330b**, **340a**, **340b**, the idler pulleys **330a**, **330b**, **340a**, **340b** absorb heat from the timing belt **315a**, **315b** (i.e., the idler pulleys **330a**, **330b**, **340a**, **340b** transfer heat away from the timing belt **315a**, **315b**). In some embodiments, the roller grill **300** may not include the lower idler pulleys **340a**, **340b** or the tensioning pulley **335a**, **335b**. Thus, in some embodiments, the presence of one or more of the idler pulleys **330a**, **330b**, **340a**, **340b** and the tensioning pulley **335a**, **335b** may determine the length and total cooling effect of the cooling cycle.

In some examples, the thermal conductivity of the timing pulleys **325a**, **325b** is less than that of one or more of the idler pulleys **330a**, **330b**, **340a**, **340b**, the tensioning pulley **335a**, **335b**, and the timing gear **345a**, **345b**. For example, in some embodiments, the thermal conductivity of the timing pulleys **325a**, **325b** may be less than or equal to 17 Btu/(hrft² F.) (29 W/(mK)) at a temperature of 250° F. (121° C.), while the thermal conductivity of one or more of the idler pulleys **330a**, **330b**, **340a**, **340b**, the tensioning pulley **335a**, **335b**, and the timing gear **345a**, **345b** may be greater than or equal to 200 Btu/(hrft² F.) (346 W/(mK)) at a temperature of 250° F. (121° C.). In some instances, the cooling cycle can drop the temperature of the timing belt **315a**, **315b** by up to 50° F. (10° C.). In some examples, the alternating heating cycles and cooling cycles may extend the life of the timing belt **315a**, **315b**. For example, the cooling cycle may provide the timing belt **315a**, **315b** with a life of up to six years, whereas a drive chain, in contrast, may need to be changed once per year.

In some embodiments, the timing pulleys **325a**, **325b** may be a low heat conductive material, such as plastic. In some embodiments, the idler pulleys **330a**, **330b** may be a high heat conductive material, such as aluminum. In some embodiments, the idler pulleys **340a**, **340b** may be a low heat conductive material, such as plastic. In some embodiments, the timing gear **345a**, **345b** may be a high heat conductive material, such as aluminum.

FIGS. 4A-4C illustrate views of another example embodiment of a roller grill 400 utilizing a chain drive assembly. The roller grill 400 includes two side housings 405 (one shown in FIG. 4A), and the weight of the roller grill 400 is supported by multiple legs 410 that are mounted underneath and near corners of a bottom housing. The roller grill 400 also includes multiple heating tubes and multiple sprockets 420 that are respectively coupled to ends of the multiple heating tubes. In some embodiments, a chain 415 provides rotary motion to the heating tubes by engaging the sprockets 420. The chain 415 is driven by one or more motors within a bottom housing of the roller grill 400 (not shown in FIGS. 4A-4B) as the chain 415 engages a drive gear 430 coupled to the motor. In this example, the roller grill 400 includes one chain drive assembly; however, in alternative embodiments, the roller grill 400 may include more than one chain drive assembly.

In some embodiments, one motor may be coupled to two chain drive assemblies located at opposing sides of the roller grill 400. In some embodiments, a first motor may be coupled to a first chain drive assembly located at a first side of the roller grill 400, while a second motor may be coupled to a second chain drive assembly located at a second side of the roller grill 400.

In some embodiments, a lubricator 425 may be attached to the side housing 405 and disposed around the chain 415 as the chain 415 travels through the drive assembly. In some examples, the lubricator 425 may be unattached to the side housing 405 and mounted on the chain 415. In this example, the lubricator 425 can have pins 450 disposed adjacent external surfaces of the lubricator 425 (e.g., protruding from the housing 405) that prevent the lubricator 425 from moving past a fixed distance from the drive sprocket 430. The lubricator 425, therefore, may be free-floating on the chain 415 (e.g., unattached to the side housing 405) and substantially prevented from moving with movement of the chain 415 towards the drive sprocket 430.

In some embodiments, the lubricator 425 may be approximately 4 inches (10 cm) long in length. The lubricator 425 includes two lubricant blocks 435, a shell cover plate 440, and a clam shell cover plate 445. Each lubricant block 435 has two grooves cut into a surface of the lubricant block 435, the surface of each lubricant block 435 disposed adjacent to and facing the mirrored surface of the other lubricant block 435. In some examples, when the surfaces of the two lubricant blocks 435 are disposed adjacent to and facing each other, the opening created by the grooves allows the plates 455 and rollers 460 of the chain 415 to travel through the lubricator 425 with engaging contact with the lubricant blocks 435.

Each lubricant block 435 is further impregnated with lubricant. In some embodiments, the lubricator 425 cleans and lubricates the chain 415 substantially constantly such that an appropriate amount of lubricant is provided to the chain 415, while excess lubricant on the chain 415 is removed. For example, the lubricator 425 can replace lubricant that may have evaporated from the chain 415 over time due to heat transferred to the chain 415, and/or the lubricator 425 can remove lubricant that may have congealed on the chain 415 over time. As the chain 415 enters the lubricant blocks 435 during operation of the roller grill 400, excess lubricant on the chain 415 is scraped away (e.g., by external edges of the lubricant blocks 435, the "T"-shaped recess defined between the lubricant blocks 435, or other edge surface). As the chain 415 continues to pass through and in contact with the facing surfaces of the lubricant blocks 435, lubricant impregnated in the lubricant blocks 435 is disposed on the chain 415. The clam shell cover plate 440, in some embodiments, can serve as a spring that urges the two lubricant blocks 435 together to

maintain their contact. Further, the shell cover plate 440 may maintain the lubricant blocks 435 disposed around the chain 415 as the chain 415 travels through the lubricator 425.

In some embodiments, the lubricator 425 can be used with any chain-driven system that needs regular lubrication maintenance to function properly. For example, the lubricator 425 may be used on a bicycle chain, a motorcycle chain, a food heating assembly chain, or otherwise. Further, although the lubricant blocks 435 are illustrated as separate portions, in some embodiments, the lubricator 425 may have a single lubricant block with one or more of the illustrated channels and/or grooves formed therethrough.

FIG. 4C illustrates a sectional view of the lubricator 425. As illustrated, the lubricant blocks 435 are urged together by the shell cover plate 440 to form an interface at matching surfaces of the blocks 435. Upon interface of the lubricant blocks 435, grooves 470a and 470b define a channel 472. In some embodiments, the channel 472 may extend an entire length of the blocks 435 with openings at each end surface of the lubricant blocks 435. As illustrated, a portion of the chain 415, such as, for example, a plate 455 of the chain 415, may fit within the channel 472. In some embodiments, the channel 472 may be sized so as to contactingly engage the portion of the chain 415 (e.g., the plates 455) as the chain 415 is moved through the lubricator 425. In such a fashion, lubricant impregnated into the lubricant blocks 435 may be transferred to the chain 415.

As illustrated, upon interface of the lubricant blocks 435, grooves 475a and 475b define another channel 477. In some embodiments, the channel 477 may extend the entire length of the blocks 435 with openings at each end surface of the lubricant blocks 435. As with the channel 472, the channel 477 may be sized so as to contactingly engage the portion of the chain 415 (e.g., the plates 455) as the chain 415 is moved through the lubricator 425. In such a fashion, lubricant impregnated into the lubricant blocks 435 may be transferred to the chain 415 in cooperation with the channel 477.

As illustrated, ridges 480a and 480b may be formed in the lubricant blocks 435 in between the grooves 470a and 475a, and grooves 470b and 475b, respectively. The ridges 480a and 480b may be sized to allow a portion of the chain 415 (e.g., the rollers 460) to move through another channel 482 formed between the lubricant blocks 435. As illustrated, the channel 482 may be open to the channels 472 and 477, thereby defining a substantially "T" shaped opening through the lubricant blocks 435. In some embodiments, lubricant from the lubricant blocks 435 may be transferred to the rollers 460 as the chain 415 is moved through the lubricant blocks 435 through, for instance, contacting engagements with the ridges 480a and 480b.

In some embodiments, lubricant on the chain 415 may be removed by the lubricant blocks 435 as the chain 415 enters into and/or moves through the lubricant blocks 435. For instance, edges on distal surfaces of the lubricant blocks 435 that define openings into the channels 472 and 477 may remove excess and/or used lubricant from the chain 415 as the chain 415 is moved over, and in contact with, such edges. In some embodiments, excess and/or used lubricant may also be removed from the chain 415 as the portions of the chain 415 (e.g., the plates 455 and rollers 460) contactingly engage the lubricant blocks 435 at the grooves 470a, 470b, 475a, and 475b, and at the ridges 480a and 480b.

FIGS. 5A-5B illustrate views of example embodiments of a roller grill tube assembly 500, 550 that may be used with a roller grill, such as one or more of roller grills 100, 200, 300 and/or 400. Referring now to FIG. 5A, in some embodiments, a roller grill tube assembly 500 includes a heating tube 505, a

sprocket **510** coupled to an end of the heating tube **505**, and a bushing **515**. In some embodiments, the sprocket **510** is installed over the heating tube **505** (e.g., press fit over the tube **505**). In some embodiments, the bushing **515** may be a bearing inserted into the sprocket **510** that acts as a thrust bearing that prevents (all or partially) metal-to-metal contact between the sprocket **510** and other metal components of a roller grill.

In some examples, the sprocket **510** may allow the roller grill tube assembly **500** to operate with a roller grill utilizing a chain drive assembly, such as the roller grill **400**. During operation of a roller grill, the bushing **515** provides a surface to transfer heat away from the heating tube **505** and the sprocket **510**, thereby reducing the wear of the sprocket **510** and a chain (e.g., the chain **415**) engaged with the sprocket **510**. In some embodiments, the bushing **515** can include a notch **520** that engages with a ridge of the heating tube **505** or a ridge of the sprocket **510** to prevent or reduce slippage of the bushing **515**. In some examples, the bushing **515** is a TEFLON™ bushing.

Referring now to FIG. **5B**, in some embodiments, a roller grill assembly **550** may include a heating tube **555**, a pulley flange **560** coupled to an end of the heating tube **555**, a timing pulley **565** coupled to the end of the heating tube **555**, and a bushing **570**. The bushing **570** may, in some embodiments, extend past the timing pulley **565** to contact a retainer plate (not shown), such as, for instance, the cover plate **280**. In some embodiments, the bushing **570** may be TEFLON™ or another bearing material. In some embodiments, the timing pulley **565** may allow the roller grill tube assembly **550** to operate with a roller grill utilizing a belt drive assembly, such as the roller grill **300**. In some examples, the pulley flange **560** may prevent the timing pulley **565** from sliding inward on the heating tube **555**. In some examples, the pulley flange **560** is made of plastic (e.g., TEFLON™) or steel (e.g., stainless or carbon).

FIGS. **6A-6D** illustrate views of example embodiments of a roller grill **600** having a chain drive assembly or a roller grill **600** having a belt drive assembly. As shown in FIG. **6A**, the illustrated roller grill **600** includes a side housing **605**, multiple heating tubes **610**, and multiple sprockets **615** that are respectively coupled to ends of the multiple heating tubes **610**. In some embodiments, as illustrated, a bearing (such as the bushing **515**) may be press-fit into each heating tube **610** and provide a wear surface with a retainer plate (not shown) so as to prevent metal-to-metal contact with the sprockets **615** and, for instance, a retainer plate.

The roller grill **600** further includes a chain glide **620** having multiple glide recesses **625**. In some embodiments, the chain glide **620** can be made of a bearing material, such as plastic, bronze, or other wearable material. In some embodiments, the chain glide **620** can have a serpentine shape that causes the chain **630** to engage more than one tooth of the sprockets **615**. For example, the chain glide **620** may cause the chain **630** to engage with two or three teeth of the sprockets **615**, rather than a single tooth in the absence of the chain glide **620**.

Engagement of the chain **630** with more than one tooth of the sprockets **615** reduces the probability of the chain **630** being displaced from the sprockets **615**. In some examples, engagement of the chain **630** with more than one tooth of the sprockets **615** reduces the frictional wear on any given point of the chain **630** and on any given tooth of the sprockets **615** by distributing forces between the chain **630** and the sprockets **615** across multiple teeth of the sprockets **615**. In some embodiments, each of the glide recesses **625** may have side skirts that maintain the position of the chain **630** on the sprockets **615**. In some examples, this can prevent damage of

one or more of the chain **630**, of the sprockets **615**, or of other components of the chain drive assembly.

During operation of the roller grill **600**, the chain **630** provides rotary motion to the heating tubes **610** by engaging the sprockets **615** that are coupled to the ends of the heating tubes **610**. The chain **630** is driven by one or more motors within a bottom housing of the roller grill **600** (not shown in FIGS. **6A-6B**) as the chain **630** engages a drive gear a coupled to the one or more motors. As the chain **630** engages the sprockets **615**, the chain **630** is contacted and further guided towards the sprockets **615** by the chain glide **620**, which causes the chain **630** to engage multiple teeth of the sprockets **615**. While the chain **630** is engaged with the teeth of the sprockets **615**, the glide recesses **625** can prevent the chain **630** from slipping off of the sprockets **615**.

Referring now to FIG. **6B**, in some embodiments, the roller grill **600** can include one or more rollers **635** coupled to the side housing **605** and disposed above and in contact with the chain **630** and between the sprockets **615**. The one or more rollers **635** can cause the chain **630** to engage more than one tooth of the sprockets **615**. In some embodiments, the position of the one or more rollers **635** can increase the engagement of the chain **630** with the teeth on two separate sprockets **615** simultaneously. In some examples, a roller **635** can be positioned above and in contact with the chain **630** and between every two sprockets **615**. In some embodiments, the chain **630** may be longer than a conventional chain for a roller grill due to increased contact between the chain **630** and the teeth of the sprockets **615**.

During operation of the roller grill **600**, the chain **630** provides rotary motion to the heating tubes **610** by engaging the sprockets **615** that are coupled to the ends of the heating tubes **610**. The chain **630** is driven by one or more motors within a bottom housing of the roller grill **600** (not shown in FIGS. **6A-6B**) as the chain **630** engages a drive gear a coupled to the one or more motors. As the chain **630** engages the sprockets **615**, the chain **630** is contacted and further guided towards the sprockets **615** by the rollers **635**, which cause the chain **630** to simultaneously engage multiple teeth of adjacent sprockets **615**. While the chain **630** is engaged with the teeth of the sprockets **615**, the rollers **635** can also help in preventing the chain **630** from slipping off of the sprockets **615**.

Turning to FIG. **6C**, another embodiment of the roller grill **600** is shown but with a belt-drive assembly that uses a timing belt **650** engaged with gears **660** to drive (e.g., rotate) one or more heating tubes **610**. This embodiment of the roller grill **600** further includes a belt glide **622** having multiple glide recesses **627**. In some embodiments, the belt glide **620** can be made of a bearing material, such as plastic, bronze, or other wearable material. In some embodiments, the belt glide **622** can have a serpentine shape that causes the belt **650** to engage more than one tooth of the gears **660**. For example, the belt glide **622** may cause the belt **650** to engage with two or three teeth of the gears **660**, rather than a single tooth in the absence of the belt glide **622**.

Engagement of the belt **650** with more than one tooth of the gears **660** reduces the probability of the belt **650** being displaced from the gears **660**. In some examples, engagement of the belt **650** with more than one tooth of the gears **660** reduces the frictional wear on any given point of the belt **650** and on any given tooth of the gears **660** by distributing forces between the belt **650** and the gears **660** across multiple teeth of the gears **660**. In some embodiments, each of the glide recesses **627** may have side skirts that maintain the position of the belt **650** on the gears **660**. In some examples, this can prevent damage of one or more of the belt **650**, of the gears **660**, or of other components of the belt drive assembly.

During operation of this embodiment of the roller grill 600 shown in FIG. 6C, the belt 650 provides rotary motion to the heating tubes 610 by engaging the gears 660 that are coupled to the ends of the heating tubes 610. The belt 650 is driven by one or more motors within a bottom housing of the roller grill 600 (not shown in FIG. 6C) as the belt 650 engages a drive gear coupled to the one or more motors. As the belt 650 engages the gears 660, the belt 650 is contacted and further guided towards the gears 660 by the belt glide 622, which causes the belt 650 to engage multiple teeth of each of the gears 660. While the belt 650 is engaged with the teeth of the gears 660, the glide recesses 627 can prevent the belt 650 from slipping off of the gears 660.

Turning to FIG. 6D, another embodiment of the roller grill 600 is shown but with a belt-drive assembly that uses a timing belt 650 engaged with gears 660 to drive (e.g., rotate) one or more heating tubes 610. This embodiment of the roller grill 600 can include one or more rollers 637 coupled to the side housing 605 and disposed above and in contact with the belt 650 and between the sprockets 615. The one or more rollers 637 can cause the belt 650 to engage more than one tooth of the gears 660. In some embodiments, the position of the one or more rollers 637 can increase the engagement of the belt 650 with the teeth on two separate gears 660 simultaneously. In some examples, a roller 637 can be positioned above and in contact with the belt 650 and between every two gears 660. In some embodiments, the belt 650 may be longer than a conventional belt for a roller grill due to increased contact between the belt 650 and the teeth of the gears 660.

During operation of the roller grill 600, the belt 650 provides rotary motion to the heating tubes 610 by engaging the gears 660 that are coupled to the ends of the heating tubes 610. The belt 650 is driven by one or more motors within a bottom housing of the roller grill 600 (not shown in FIG. 6D) as the belt 650 engages a drive gear coupled to the one or more motors. As the belt 650 engages the gears 660, the belt 650 is contacted and further guided towards the gears 660 by the rollers 637, which cause the belt 650 to simultaneously engage multiple teeth of adjacent gears 660. While the belt 650 is engaged with the teeth of the gears 660, the rollers 637 can also help in preventing the belt 650 from slipping off of the gears 660.

FIGS. 7A-7B illustrate example embodiments of a bearing block that may be used to support a rotating shaft of a roller grill, such as, for example, the roller grill 200 illustrated in FIGS. 2A-2D. For instance, in some embodiments, one or more of the illustrated bearing blocks 700 and/or 750 may be used to support (e.g., rotatably) the shaft 235 on which the worm gears 230 are disposed. For example, in some embodiments, a bearing block 700 or a bearing block 750 may be mounted on the roller grill 200 at or near the illustrated locations of the illustrated bearing blocks 260 and may take the place of the bearing blocks 260. For instance, in some embodiments, there may be four bearing blocks 700 and/or 750 mounted and arranged to receive a bearing attached to the shaft 235 therethrough. Alternatively, there may be more or fewer bearing blocks 700 and/or 750 arranged on the roller grill 200 to receive the shaft 235 therethrough.

Turning to FIG. 7A, the illustrated bearing block 700 includes a vertical block 715 inserted through a yoke 705 and coupled thereto. In some embodiments, the vertical block 715 may be directly coupled to the yoke 705, such as, for example, by welding, adhesive, or other technique. A shaft with an attached bearing, such as the shaft 235, may be inserted through a bore 720 of the vertical block 715 and be supported (e.g., rotatably) by a bearing (e.g., a roller bearing or other type of bearing) statically mounted within the bore 720 of the

vertical block 715. Thus, in some embodiments, the shaft 235 may rotate with reduced friction in the bearing block 700. In some embodiments, the vertical block 715 may comprise a press fit bearing for the shaft 235 made of, for instance, stainless steel, cold rolled steel, or other appropriate material.

The yoke 705, as illustrated, includes two winged extensions 713, with each extension 713 having a mount hole 710 therethrough. In some embodiments, the yoke 705 may be directly coupled to the side housing 205 through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount holes 710. In alternative embodiments, the yoke 705 may be directly coupled to a plenum plate, such as the plenum plate 350, through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount holes 710.

As illustrated, the vertical block 715 includes a mounting ledge 730. In some embodiments, the mounting ledge 730 may interface with a portion of the roller grill 200, such as, for example, a plate on which the worm gears 230 may be mounted. In some embodiments, for example, the mounting ledge 730 may provide for an increased alignment of the bearing block 700 when mounted to the roller grill 200.

The illustrated bearing block 700 also includes a threaded bore 725. In some embodiments, a retainer or cover plate (such as the retainer plate 930 illustrated in FIG. 9B) may be attached to the bearing block 700 by a mechanical fastener threaded into the bore 725 and through a tab 940 of the retainer plate. This may, in some embodiments, provide or help provide for the bearing block 700 to be held substantially stationary during operation of the roller grill. For instance, the bearing block 700 may be held substantially stationary so that it does not rotate when the shaft 235 rotates and also is not urged laterally in parallel to the longitudinal axis of the shaft 235 due to thrust forces exerted by rotation of the worm gears 230.

Turning to FIG. 7B, the illustrated bearing block 750 includes a bearing ring 770 coupled to a yoke 755. In some embodiments, for example, the bearing ring 770 may be integral with the yoke 755, with each component manufactured of a metal or plastic, such as noryl (PPO) plastic (30% glass filled). A shaft, such as the shaft 235, may be inserted through a bore 775 of the bearing ring 770 and be supported (e.g., rotatably) by a bearing (e.g., a roller bearing or other type of bearing) statically mounted within the bore 775 of the bearing ring 770. Thus, in some embodiments, the shaft 235 may rotate with reduced friction in the bearing block 750. In some embodiments, the bearing ring 770 may comprise a press fit bearing for the shaft 235 and may include a torque surface 780, as illustrated. In some embodiments, the torque surface 780 may prevent (all or partially) rotation of the bearing in the bore 775 during rotation of the shaft 235 within the bearing, as well as longitudinal movement of the bearing under a thrust force applied by the worm gears 230.

The yoke 755, as illustrated, includes two winged extensions 760, with each extension 760 having a mount slot 765 therethrough. In some embodiments, the yoke 755 may be directly coupled to the side housing 205 through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount slots 765. In alternative embodiments, the yoke 755 may be directly coupled to a plenum plate, such as the plenum plate 350, through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount slots 765.

As illustrated, the bearing ring 770 includes a mounting ledge 790. In some embodiments, the mounting ledge 790 may interface with a portion of the roller grill 200, such as, for example, a plate on which the worm gears 230 may be

mounted. In some embodiments, for example, the mounting ledge 790 may provide for an increased alignment of the bearing block 750 when mounted to the roller grill 200 (e.g., a plenum plate).

The illustrated bearing block 750 also includes a threaded bore 785. In some embodiments, a retainer or cover plate (such as the retainer plate 930 illustrated in FIG. 9B) may be attached to the bearing block 750 by a mechanical fastener threaded into the bore 785 and through a tab 940 of the retainer plate. This may, in some embodiments, provide or help provide for the bearing block 750 to be held substantially stationary during operation of the roller grill. For instance, the bearing block 750 may be held substantially stationary so that it does not rotate when the shaft 235 rotates and also is not urged laterally in parallel to the longitudinal axis of the shaft 235 due to thrust forces exerted by rotation of the worm gears 230.

FIGS. 8A-8D illustrate an example helical gear 800 that may be used in a roller grill, such as, for example, the roller grill 200 illustrated in FIGS. 2A-2D. In some embodiments of the roller grill 200, for instance, the helical gear 800 may be coupled to a heating tube 220 (or other heating tube) and used to drive (e.g., rotate) the heating tube 220. For example, the helical gear 800 may be driven by the spur gear 225 and mounted on the shaft 235.

As illustrated, the helical gear 800 includes an outer diameter surface 810 coupled to (e.g., attached to or integral with) a gear head 805 having multiple teeth 815 disposed around an outer surface of the gear head 805. A bore 820 extends through the gear head 805 and outer diameter surface 810 and shares a centerline with the gear head 805 and the outer diameter surface 810. As illustrated, the teeth 815 may be angled to form a helical gear (e.g., at about a 5° angle offset). In some embodiments, there may be 21 teeth 815, with each tooth 815 having a pitch diameter of about 1.2 inches (3.1 cm), an outside diameter of about 1.3 inches (3.3 cm), a root diameter of about 1.08 inches (2.74 cm), and a tooth thickness at the pitch diameter of about 0.1 inches (0.3 cm). Further, in some embodiments, the diameter of the bore 820 is about 0.75 inches (1.91 cm).

As illustrated in FIG. 8D, an end of the helical gear 800 that may be coupled to a heating tube includes a beveled surface 825 around a circumference of the outer diameter surface 810. In some embodiments, the beveled surface 825 may be set-off at an angle of about 30° from an interior surface of the outer diameter surface 810. Alternatively, other angular offsets are possible. In some embodiments, the beveled surface 825 may allow a heating element to be more easily inserted through the helical gear 800 from the heating tube 220.

As further illustrated in FIG. 8D, the gear head 805 also includes a beveled surface 830 around a circumference of the gear head 805. In some embodiments, the beveled surface 830 may be set-off at an angle of about 45° from an interior surface of the gear head 805. Alternatively, other angular offsets are possible. In some embodiments, a retainer or cover plate (such as the retainer plate 930) may include a concave portion 935 that protrudes into the gear head 805 adjacent the beveled surface 830. Thus, there may be more space allowed for wiring coupled to a heating element passing through the heating tube 220.

In some embodiments, the helical gear 800 may be coupled to the heating tube 220 (or another heating tube) as follows. First the outer diameter surface 810 may be inserted (e.g., all or partially) into the heating tube 220 until an end of the heating tube 220 is at or adjacent the gear head 805. Next, the heating tube 220 may be punched into the outer diameter surface 810 (e.g., by compressing the heating tube 220 into

the outer diameter surface 810 and/or inserting a davit (not shown) through the heating tube 220 and outer diameter surface 810). Next, the assembly including the helical gear 800 and heating tube 220 may be rotated, for example, about 180°. The heating tube 220 may be punched again into the outer diameter surface 810 (e.g., by installing the heating tube 220 over the outer diameter surface 810) at a location about 180° about from the first punch location. In such a manner, the helical gear 800 may be coupled to the heating tube 220.

FIGS. 9A-9B illustrate an example bushing 900 that may be used in a roller grill, such as, for example, one or more of the roller grills 100, 200, 300, 400, and/or 600. In some embodiments, for example, the bushing 900 may be used as a bearing surface through which a heating tube (such as, for instance, the heating tube 120) may be inserted. As illustrated, the bushing 900 includes a pair of tubulars 910 connected by a web 905. Although FIG. 9A shows two tubulars 910, more or fewer tubulars 910 may be connected by the web 905. In some embodiments, the bushing 900 may be installed against an end plate of a roller grill, such as the side housing 205, such that the web 905 is mounted adjacent an outboard surface of the side housing 205 (e.g., facing a side plenum space of the roller grill) and the tubular portions 910 are inserted through holes in the side housing 205.

As illustrated in FIG. 9A, a retainer plate 915 may also be mounted in a roller grill substantially adjacent the bushing 900. The retainer plate 915 may include a number of apertures 925 receiving the tubulars 910. For instance, in some embodiments, the retainer plate 915 may be a single piece that extends (all or partially) a width of the roller grill with a 1:1 ratio of apertures 925 to heating tubes. In some embodiments, the retainer plate 915 may prevent (all or partially) the bushing 900 from movement (e.g., rotational) during rotation of heating tubes in the roller grill.

Turning to FIG. 9B, an example embodiment of the bushing 900 is illustrated with the roller grill 200. Alternatively, the bushing 900 may be used in the roller grill 100 illustrated in FIG. 1. As illustrated, the bushing 900 may be inserted through the side housing 205 such that the web 905 is in contacting engagement with an outboard surface of the side housing 205. The retainer plate 915 may be inserted over the tubulars 910 that extend into the plenum space adjacent the outboard surface of the side housing 205, thereby sandwiching the web 905 against the side housing 205. In some embodiments, the retainer plate 915 may be attached (e.g., mechanically) to the side housing 205.

As further illustrated in FIG. 9B, the retainer plate 930 may be mounted adjacent the gear head 805 of the helical gear 800 such that the concave portion 935 extends into the gear head 805 adjacent the beveled surface 830. In some embodiments, electrical wiring coupled to a heating element (not shown) inserted through the heating tube 220 may be installed within a volume defined by the concave portion 935, thereby saving space within the plenum 223.

A number of embodiments have been described. Nevertheless, it will be understood that various modifications may be made. For example, various combinations of the components described herein may be provided for embodiments of similar apparatus. For instance, although belts and chains are shown in the illustrated embodiments, other types of looped surfaces (e.g., continuous looped surfaces) may be used in place of belts or chains. Accordingly, other embodiments are within the scope of the present disclosure.

What is claimed is:

1. A roller grill for heating a pre-cooked food product, comprising:

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a housing structure adapted to support the roller grill;
 a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product;
 a plurality of rollers mounted in a row, each roller mounted on an end of a corresponding tube and comprising a plurality of detented projections extending from a circumferential surface of the roller;
 a drive assembly, comprising:
 a motor comprising a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed; and
 a fan coupled to the motor, the fan and motor mounted in a bottom portion of the housing structure that is positioned beneath the plurality of tubes;
 a chain coupled to the shaft and contactingly engaged with the detented projections of the plurality of rollers, the chain adapted to transfer the rotational power to the plurality of rollers at a second rotational speed; and
 an elongated chain guide mounted to the housing structure, the elongated chain guide formed as a continuous serpentine surface that extends across a side portion of this housing above the plurality of rollers, the continuous serpentine surface comprising alternating peaked portions and recessed portions arranged along a length of the elongated chain guide, the peaked portions extending from the housing structure at locations between consecutively mounted rollers in the row of the plurality of rollers and in contacting engagement with the chain to bias the chain in contacting engagement with at least two detented projections of each roller of the plurality of rollers mounted in the row, wherein
 the fan is positioned to circulate an airflow from an ambient space, through a vent in the bottom portion of the housing, and to the side portion of the housing to cool the chain.

2. The roller grill of claim 1, wherein the first and second rotational speeds are substantially identical.

3. The roller grill of claim 1, wherein the plurality of rollers comprise a plurality of sprockets.

4. The roller grill of claim 3, wherein the plurality of detented projections comprise a plurality of teeth extending from respective circumferential surfaces of the plurality of sprockets, and
 the chain is contactingly engaged with the plurality of teeth.

5. The roller grill of claim 4, wherein the chain is contactingly engaged with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

6. The roller grill of claim 4, wherein the elongated chain guide contactingly guides the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

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7. The roller grill of claim 4, wherein the peaked portions are arranged between adjacent sprockets of the plurality of sprockets in the row.

8. An apparatus for heating a pre-cooked food product, comprising:
 a housing structure comprising a bottom housing portion and side housing portions and adapted to support the apparatus;
 a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product;
 a motor comprising a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed;
 a fan coupled to the motor, the fan and motor mounted in the bottom housing portion that is positioned between the side housing portions and beneath the plurality of tubes;
 a plurality of sprockets mounted to corresponding ends of the plurality of tubes, the sprockets operable to receive the generated rotational power and transfer the generated rotational power to the plurality of tubes;
 a timing chain that is operable to transfer the generated rotational power from the motor to the plurality of sprockets;
 a continuous elongated serpentine surface mounted to the housing structure in one of the side housing portions and extending across the side housing portion above the plurality of sprockets, the continuous elongated serpentine surface comprising alternating peaked portions and recessed portions arranged along a length of the continuous elongated serpentine surface, the peaked portions extending from the housing structure at locations between consecutively mounted sprockets of the plurality of sprockets and in contact with the timing chain and operable to urge the timing chain into contacting engagement with at least two teeth of each of the plurality of sprockets; and
 the fan is positioned to circulate an airflow from an ambient space, through a vent in the bottom housing portion, and to the side housing portion to cool the timing chain.

9. The apparatus of claim 8, wherein the elongated serpentine surface comprises a chain guide.

10. The apparatus of claim 9, wherein peaked portions of the chain guide are arranged between adjacent sprockets of the plurality of sprockets.

11. The roller grill of claim 1, wherein the housing structure comprises a plenum panel that serves as a heat sink to receive heat from one or more of the plurality of tubes.

12. The roller grill of claim 1, wherein the recessed portions are positioned adjacent the plurality of rollers and in contacting engagement with the chain.

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